9-4933-200-35

TM 9-4933-200-35

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

OPERATION AND FIELD AND DEPOT MAINTENANCE

PULLOVER GAGES BORESCOPES M1 AND M2 AND PRESSURE GAGE M3

This reprint includes all changes in effect at the time of publication; Change 1.

HEADQUARTERS, DEPARTMENT OF THE ARMY
AUGUST 1958

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CHANGE
No. 1

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 7 *January 1970*

DS, GS, and Depot Maintenance Manual

PULLOVER GAGES AND BORESCOPES M1 AND M2

TM 9-4933-200-35, 12 August 1958, is changed as follows:

Change title to read as shown above.

All reference to "240-mm" and "280-mm" is deleted.

All reference to "Pressure Gage M3" is deleted.

Page 2. Paragraph 1*c* is superseded as follows:

c. The reporting of errors, omissions, and recommendations for improving this publication by the individual user is encouraged. Reports should be submitted on DA Form 2028 (Recommended Changes to Publications) and forwarded direct to the Commanding General, U. S. Army Weapons Command, ATTN: AMSWE-SMM-P, Rock Island, Ill. 61201.

Paragraph 1*d* is superseded as follows:

d. This manual is one of a series relating to cannon bore inspection. The other technical manuals and supply catalogs are —

SC 4933-95-CL-E09	Accessory Outfit for Pullover Gages: Basic (4933-348-8652) and Supplemental Pullover Gages.
SC 6650-95-CL-E01	Borescope: M1 and M2.
TM 9-1000-202-10	Tanks, Self-Propelled and Towed Guns and Howitzers, and Recoilless Rifles: Procedure for Estimating or Determining Remaining Round Life of Cannon Tubes.
TM 9-1000-202-35	Evaluation of Cannon Tubes.
TM 9-4933-200-35P	DS, GS, and Depot Maintenance Repair Parts and Special Tools List Gage, Pullover, with Containers, 37-MM through 8-inch and Accessory Outfit for Pullover Gages.
TM 9-6650-231-35P	DS, GS, and Depot Maintenance Repair Parts and Special Tools Lists Borescopes M1 and M2.

Page 6. Figure 8 is superseded as follows:

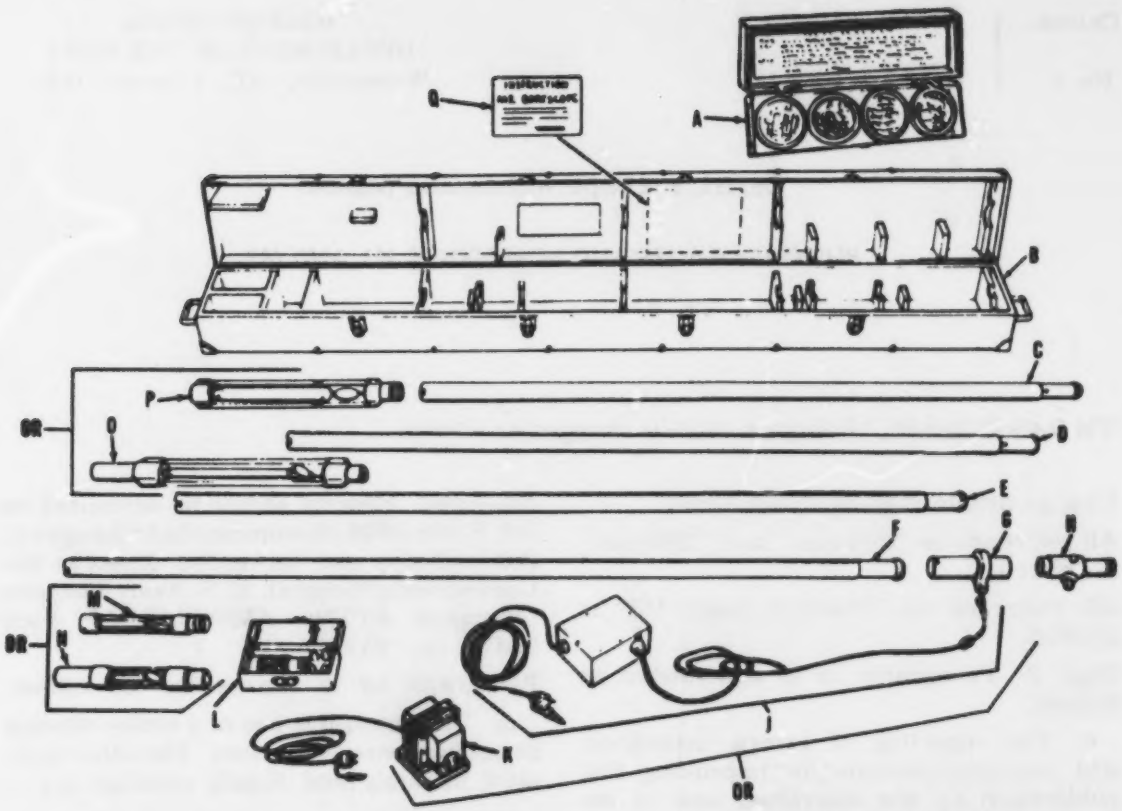

A. BORE EVALUATION SET
B. BORESCOPE CASE
C. OBJECTIVE TUBE ASSY
D. EXTENSION TUBE I ASSY
E. EXTENSION TUBE II ASSY
F. EXTENSION TUBE III ASSY
G. ADAPTER TUBE ASSY
H. EYEPIECE ASSY
J. POWER SUPPLY ASSY (INCANDESCENT)
K. POWER SUPPLY ASSY (FLUORESCENT)
L. ILLUMINATING PRISM HEAD
M. INCANDESCENT HEAD ASSY (SMALL)
N. FLUORESCENT HEAD ASSY (SMALL)
O. FLUORESCENT HEAD ASSY (LARGE)
P. INCANDESCENT HEAD ASSY (LARGE)
Q. INSTRUCTION PLATE
OR
WE 60090A

Figure 8. Boroscope M2.

Page 11. The following caution is added after paragraph 5*b*(5):

CAUTION: Use fluorescent power supply (8772997) with fluorescent illuminating heads and incandescent power supply (8770670) with incandescent illuminating heads.

Page 12, paragraph 5*b*(5)(*a*). Last sentence is changed to read: The lamp is of the long tubular type (fig. 20) or the fluorescent type (fig. 20.1).

Figure 20. The title is changed to read as follows: (Small incandescent illuminating head assembly for 57-mm through 90-mm weapons.

Figure 20.1 is added as follows:

WE 63544

Figure 20.1. Small fluorescent illuminating head assembly for 57-mm through 90-mm weapons.

Paragraph 5*b*(5)(*b*). Last sentence is changed to read: The lamp is of the long tubular type (fig. 21) or the fluorescent type (fig. 21.1).

Figure 21. Title is changed to read: Large incandescent illuminating head assembly for 105-mm through 8-inch cannon.

Figure 21.1 is added as follows:

WE 63543

Figure 21.1. Large fluorescent illuminating head assembly for 105-mm through 8-inch cannon.

Page 13, paragraph 5*b*(6). Title is changed to read: *Incandescent lamp power supply assembly.*

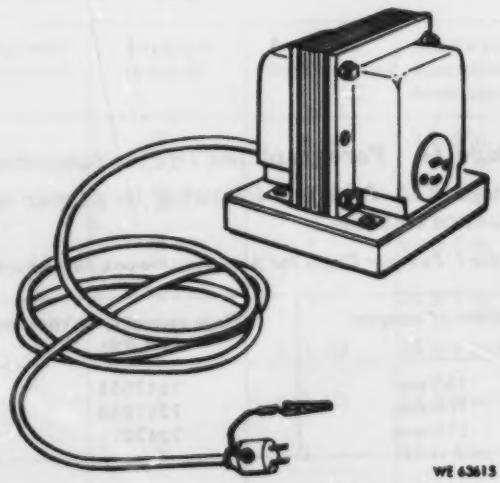
Paragrph 5*b*(6). The following caution is added after paragraph 5*b*(6).

CAUTION: Use fluorescent power supply with fluorescent illuminating heads and incandescent power supply with incandescent illuminating heads.

Paragraph 5*b*(6.1) is added after paragraph 5*b*(6).

(6.1) *Flourescent lamp power supply assembly.* The power supply assembly (fig. 8 and 23.1) is an isolating transformer requiring an input of 110-125 volts, 60 cycles, AC. This transformer serves to isolate the operator from the power source, thereby eliminating the chance of electrical shock. The input lead is of the 2-prong, 3-wire type with a two amp fuse incorporated for safety. The third wire has an alligator type clamp for grounding purposes. The output lead supplies 110-125 volts, 60 cycles, 100 watts continuous. This lead has a connector with a clamping ring that attaches to the collector housing on the borescope. The lead also is provided with a single-pole switch for safety purposes and ease of operation.

Figure 23.1 is added as follows:



WE 63615

Figure 23.1. Fluorescent power supply assembly.

Figure 24 is superseded as follows:

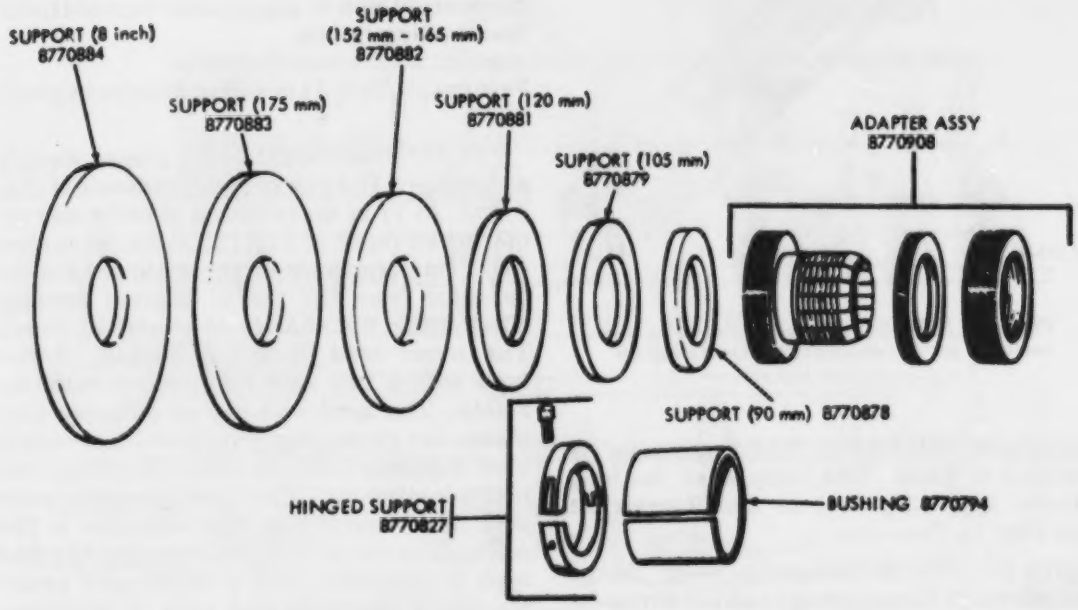


Figure 24. Borescope M2 supports and adapter assembly.

Page 14. Paragraph 5*b*(7)(*c*) is rescinded.

Page 17. Add the following in proper sequence to table I.

Table I. Pullover Gages for Artillery Weapon Inspection

Caliber of weapon	*Gage assembly w/container part Nos.*
152-mm	7247952
165-mm	7247953
175-mm	7247076

Page 18. Add the following in proper sequence to table III.

Table III. Pullover Gage Stops for Artillery Weapon Inspection

Caliber of weapon	*Stop length*	*Stop part No.*
152-mm	9	7244852
165-mm	9	7244852
175-mm	10	7244855

Paragraph 10*d*. Seventh sentence is changed to read: Read the scale of the gage, and confirm with vernier caliper (fig. 30.1).

Page 19. Figure 30.1 is added as follows:

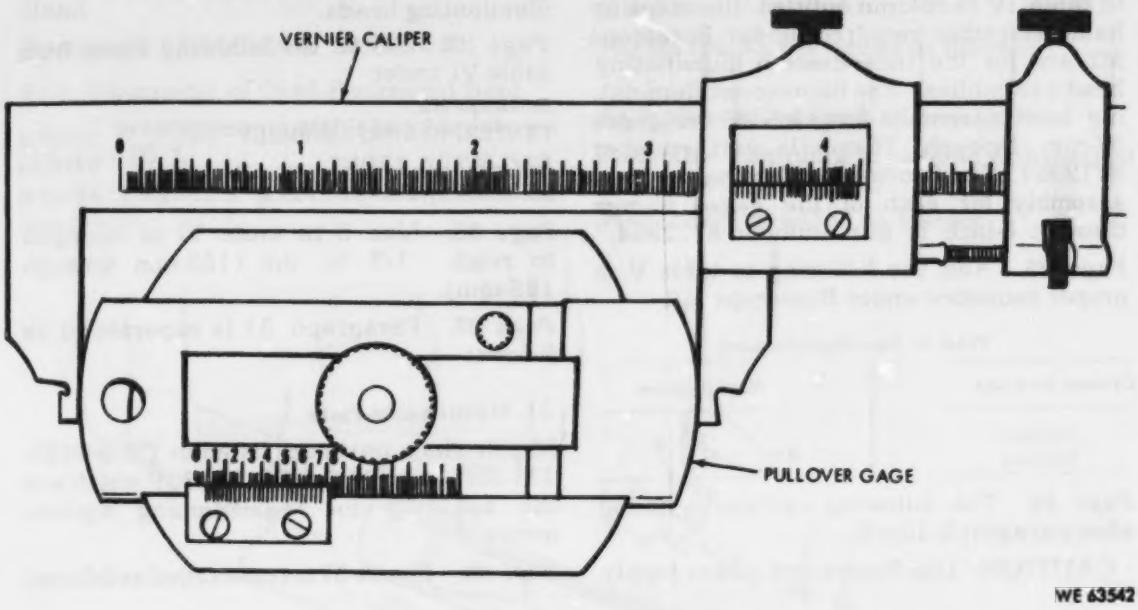


Figure 30.1. Calibrating pullover gage with vernier caliper.

Page 22. **Add the following to table IV in proper sequence under Borescope M2.**

Table IV. Assembly of Borescopes

Caliber	*Weapon being inspected*	*Length of gun*[1]	*Illuminating head assembly required*	*Supports required*	*Extension tube required*	*Length of assembled borescope*
90-mm	90-mm recoilless rifle M67.	4 ft 1 in.	[3]8772964	2	None	7 ft 8 in.
150-mm	150-mm howitzer M102.	11 ft 11 in.	[3]8772964	3	I	14 ft 3 in.
152-mm	152-mm gun-launcher M81.	9 ft 8 in.	[3]8772964	3	I	14 ft 3 in.
165-mm	165-mm gun cannon M135.	8 ft 9 in.	[3]8772964	3	I	14 ft 3 in.
175-mm	175-mm gun cannon M113.	35 ft 6 in.	[3]8772964	5	I, II, III	28 ft 9 in.[2]
175-mm	175-mm gun cannon M113E1	35 ft 6 in.	[3]8772964	5	I, II, III	28 ft 9 in.[2]
8-Inch	8-Inch howitzer M2A1E1	16 ft 8 in.	[3]8772964	3	I, II	22 ft 2 in.

[3]Part number of fluorescent illuminating head assembly (see addition to para 12a (below).

Page 23. The following three sentences are added to paragraph 12*a*. Part numbers in table IV in column entitled 'Illuminating head assembly required' under Borescope M2 are for the incandescent illuminating head assemblies. The fluorescent illuminating head assembly for each of the gages 57-mm through 76-mm is part number 8772987. The fluorescent illuminating head assembly for each of the gages 90-mm through 8-inch is part number 8772964."

Page 25. Add the following to table V in proper sequence under Borescope M2.

Table V. Bore Magnification

Cannon bore size	*Magnification*
152-mm	1.2
165-mm	1.2

Page 26. The following caution is added after paragraph 12*a*(8).

CAUTION: Use fluorescent power supply with fluorescent illuminating heads and incandescent power supply with incandescent illuminating heads.

Page 32. Delete the following items from table VI under

Borescope M2.

CENTERING RING ASSEMBLY	8770773
REFLECTOR, FRONT	8770804
REFLECTOR, REAR	8770805

Page 33. Line 6 in table VI is changed to read: 1/2 in. thk (152-mm through 165-mm).

Page 35. Paragraph 31 is superseded as follows:

31. Maintenance Parts

Maintenance parts are listed in TM 9-6650-231-35P and TM 9-4933-200-35P which are the authority for requisitioning replacements.

Page 36. Figure 57 is superseded as follows:

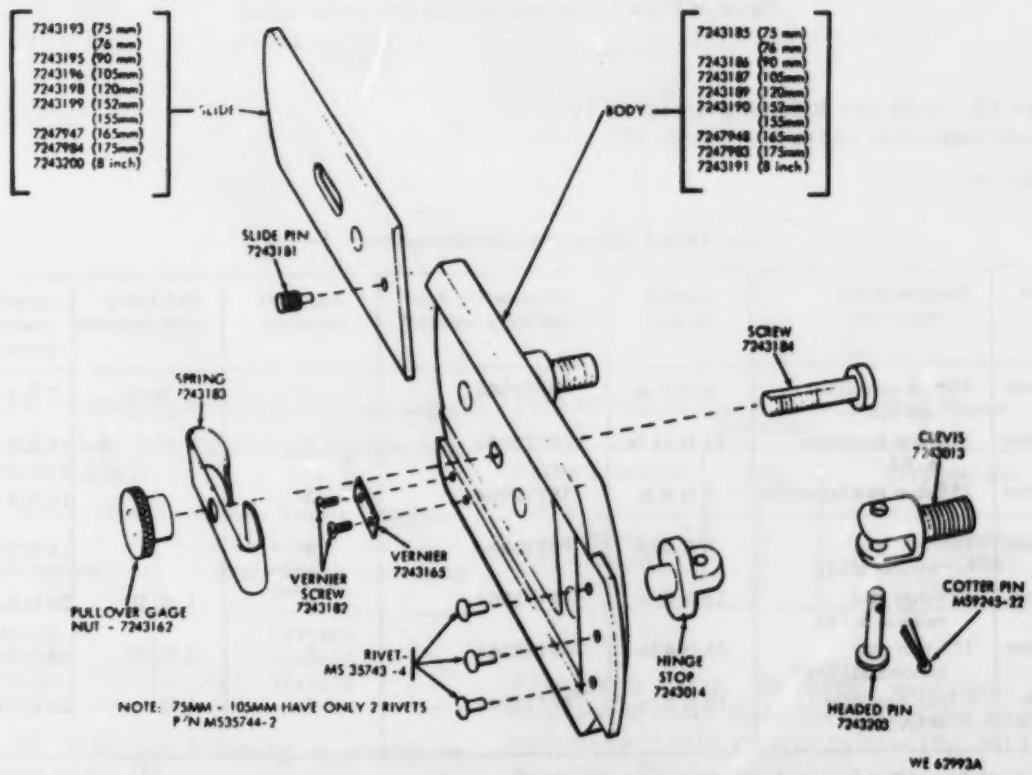


Figure 57. Pullover gage (75-mm through 8-inch weapon) — exploded view.

Page 39, paragraph 51. Title is changed to read: Disassembly of Small Incandescent Head.

Paragraph 51.1 is added as follows:

51.1. Disassembly of Small Fluorescent Head

a. The components of this head are shown in figure 60.1.

b. Disassemble according to alphabetical sequence.

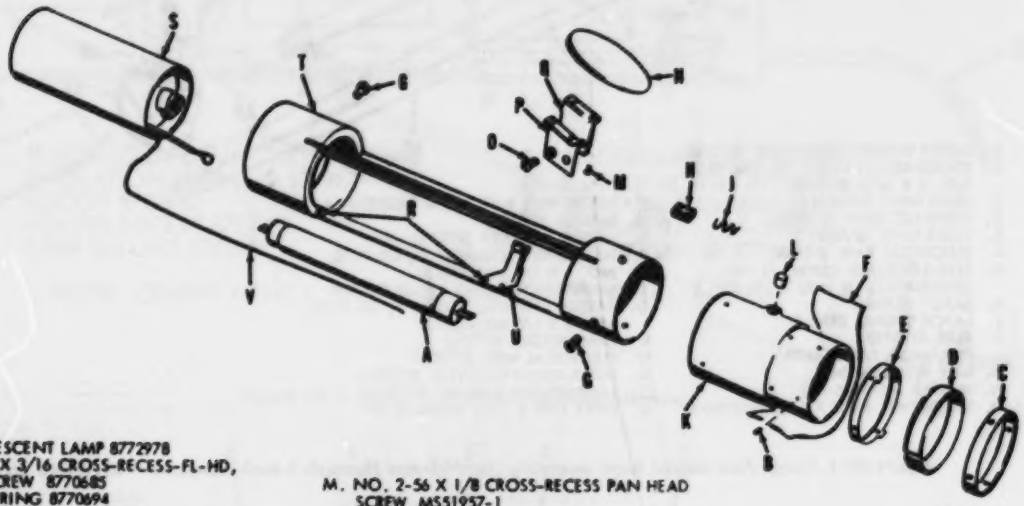
Page 40, paragraph 53. Title is changed to read: Assembly of Small Incandescent Head.

Paragraph 53.1 is added as follows:

53.1. Assembly of Small Fluorescent Head

Assemble according to reverse alphabetical sequence in figure 60.1.

Figure 60.1 is added as follows:



A. FLUORESCENT LAMP 8772978
B. NO. 0 X 3/16 CROSS-RECESS-FL-HD, BRS. SCREW 8770685
C. HEAD RING 8770694
D. CONTACT RING 8770693
E. LOCK RING 8770692
F. ELECTRICAL TAPE 8770684
G. SELF LOCKING SCREW 0.112D X 1/4 CROSS-RECESS 8772491
H. LATCH 8770682
J. LATCH SPRING 8770681
K. ILLUMINATING HEAD TUBE 8770683
L. STRAIGHT HEADLESS PIN 1/4D X 1/4 8770686
M. NO. 2-56 X 1/8 CROSS-RECESS PAN HEAD SCREW MS51957-1
N. MIRROR 8770677
O. NO.4 X 3/16 SCREW MS35206-212
P. MIRROR BRACKET 8770678 (LH)
Q. MIRROR BRACKET 8770679 (RH)
R. OVALHEAD RIVET 0.061 D X 0.219 MS16535-5
S. HOUSING ASSEMBLY 8772985
T. LAMP HOUSING ASSEMBLY 8772976
U. LAMP HOLDER SUPPORT 8772988
V. ELECTRICAL WIRE 8772991

WE 60091A

Figure 60.1. Small fluorescent head assembly for 57-mm through 90-mm weapons — exploded view.

Page 41, paragraph 56. Title is changed to read: Disassembly of Large Incandescent Head.

Paragraph 56.1 is added as follows:

56.1. Disassembly of Large Fluorescent Head

a. The components of the large fluorescent head are shown in figure 62.1.

b. Disassemble according to alphabetical sequence in figure 62.1.

Figure 62.1 is added as follows:

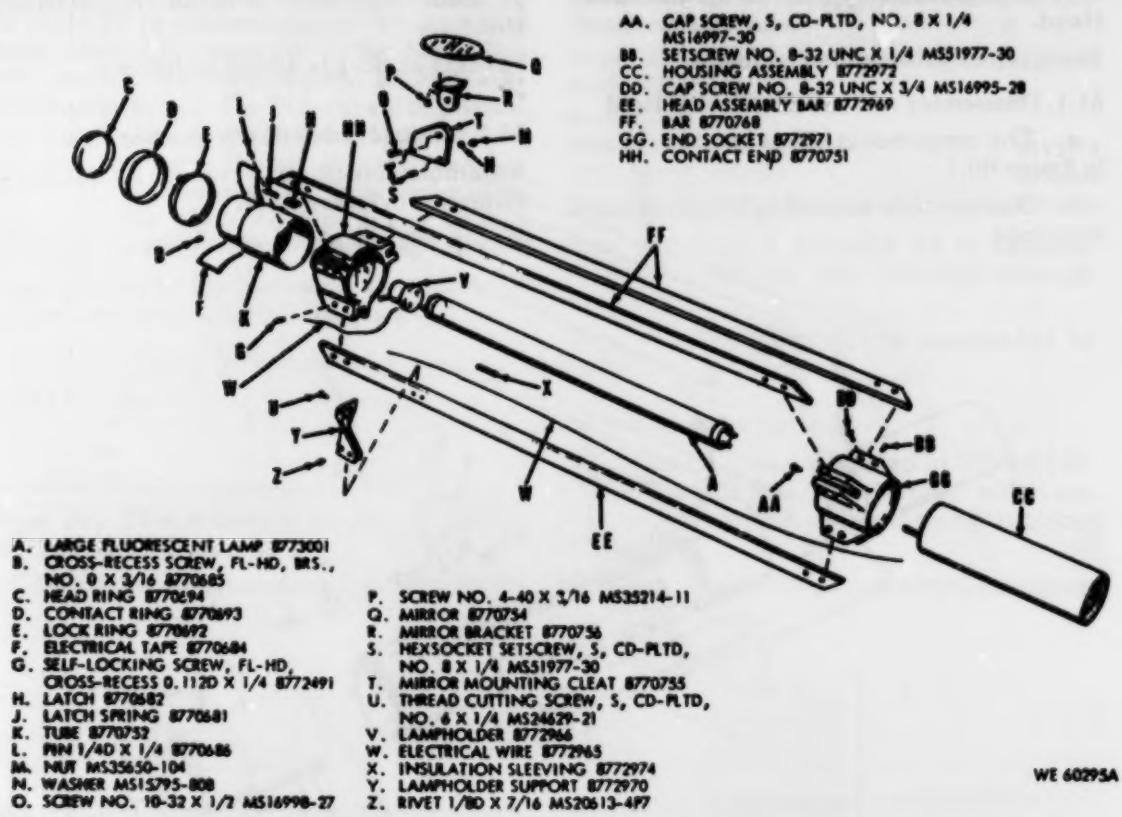

AA. CAP SCREW, S, CD-PLTD, NO. 8 X 1/4 MS16997-30
BB. SETSCREW NO. 8-32 UNC X 1/4 MS51977-30
CC. HOUSING ASSEMBLY 8772972
DD. CAP SCREW NO. 8-32 UNC X 3/4 MS16995-28
EE. HEAD ASSEMBLY BAR 8772969
FF. BAR 8770768
GG. END SOCKET 8772971
HH. CONTACT END 8770751
A. LARGE FLUORESCENT LAMP 8773001
B. CROSS-RECESS SCREW, FL-HD, BRS., NO. 0 X 3/16 8770685
C. HEAD RING 8770694
D. CONTACT RING 8770693
E. LOCK RING 8770692
F. ELECTRICAL TAPE 8770684
G. SELF-LOCKING SCREW, FL-HD, CROSS-RECESS 0.112D X 1/4 8772491
H. LATCH 8770682
J. LATCH SPRING 8770681
K. TUBE 8770732
L. PIN 1/4D X 1/4 8770686
M. NUT MS35650-104
N. WASHER MS15795-808
O. SCREW NO. 10-32 X 1/2 MS16998-27
P. SCREW NO. 4-40 X 3/16 MS35214-11
Q. MIRROR 8770754
R. MIRROR BRACKET 8770756
S. HEXSOCKET SETSCREW, S, CD-PLTD, NO. 8 X 1/4 MS51977-30
T. MIRROR MOUNTING CLEAT 8770755
U. THREAD CUTTING SCREW, S, CD-PLTD, NO. 6 X 1/4 MS24629-21
V. LAMPHOLDER 8772966
W. ELECTRICAL WIRE 8772965
X. INSULATION SLEEVING 8772974
Y. LAMPHOLDER SUPPORT 8772970
Z. RIVET 1/8D X 7/16 MS20613-4F7
WE 60295A

Figure 62.1. Large fluorescent head assembly for 105-mm through 8-inch weapons — exploded view.

Page 42, paragraph 58. Title is changed to read: Assembly of Large Incandescent Head

Paragraph 58.1 is added as follows:

58.1. Assembly of Large Fluorescent Head

Assemble according to reverse alphabetical sequence in figure 62.1.

Page 47. Paragraph 65*j*(2)(*f*) is rescinded.

Page 53, paragraph 71. Second sentence is rescinded.

Page 56, paragraph 74c(1). Second sentence is rescinded.

Page 58. Paragraphs 75.1 and 75.2 are added after paragraph 75 and figures 77.1 and 77.2 are added as follows:

75.1. Small Fluorescent Housing Assembly

a. Description. The components of the small housing assembly are shown in figure 77.1.

b. Disassembly. Disassemble according to alphabetical sequence in figure 77.1.

c. In Process Inspection and Repair. Inspect ballast, housing, socket, and lampholder for cracks. Replace if necessary.

d. Assembly. Assemble according to reverse alphabetical sequence in figure 77.1.

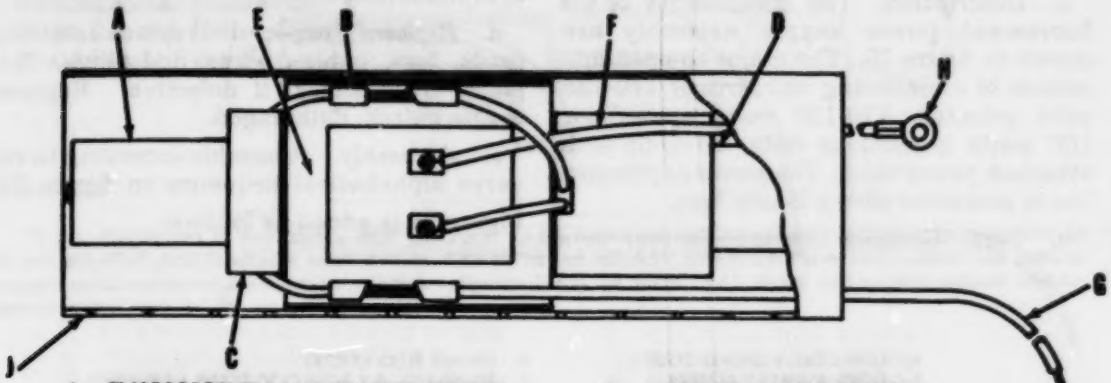
75.2. Large Fluorescent Housing Assembly

a. Description. The components of the large housing assembly are shown in figure 77.2.

b. Disassembly. Disassemble according to alphabetical sequence in figure 77.2.

c. In Process Inspection and Repair. Inspect ballast, housing, socket, and lampholder for cracks. Replace parts as needed.

d. Assembly. Assemble according to reverse alphabetical sequence in figure 77.2.

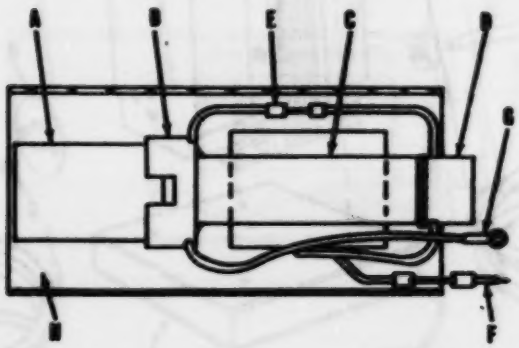


A. FLUORESCENT LAMP STARTER 8772998
B. INSULATION SLEEVING 8772974
C. SOCKET 8772980
D. HOLDER SOCKET 8772982
E. LAMP BALLAST 8772979
F. ELECTRICAL WIRE 8772984
G. ELECTRICAL WIRE 8772999
H. TERMINAL LUG MS35430-3 9/32 W 9/16 L, 14-20 AWG
J. TUBE HOUSING 8773000

NOTE: CEMENT ITEMS C, D, E AND J WITH ADHESIVE MIL-A-81236

WE 60296A

Figure 77.1. Small fluorescent housing assembly.



A. LAMP STARTER 8772998
B. SOCKET 8772980
C. LAMP BALLAST 8772981
D. LAMPHOLDER 8772977
E. INSULATION SLEEVING 8772983
F. WIRE 8772991
G. LUG MS35430-2
H. TUBE HOUSING 8772975

NOTE: CEMENT ITEMS B, C, D AND H WITH ADHESIVE FSN 8040-849-5195

WE 60293A

Figure 77.2. Large fluorescent housing assembly.

Paragraph 76. Title is changed to read: Incandescent Power Supply Assembly

Page 59. Paragraph 76.1 is added as follows:

76.1. Fluorescent Power Supply Assembly

a. Description. The components of the fluorescent power supply assembly are shown in figure 79. The major components consist of an isolating transformer 110-125 volts primary, 110-125 volts secondary, 100 watts continuous duty, 60 cycle with attached power cord. The power or primary line is protected with a 2-amp fuse.

b. Test. Connect the transformer to a 110-125 volt power source and test transformer primary with voltmeter. Test secondary for 110-125 volt output. Test toggle switch in open and closed positions. Test cords for continuity.

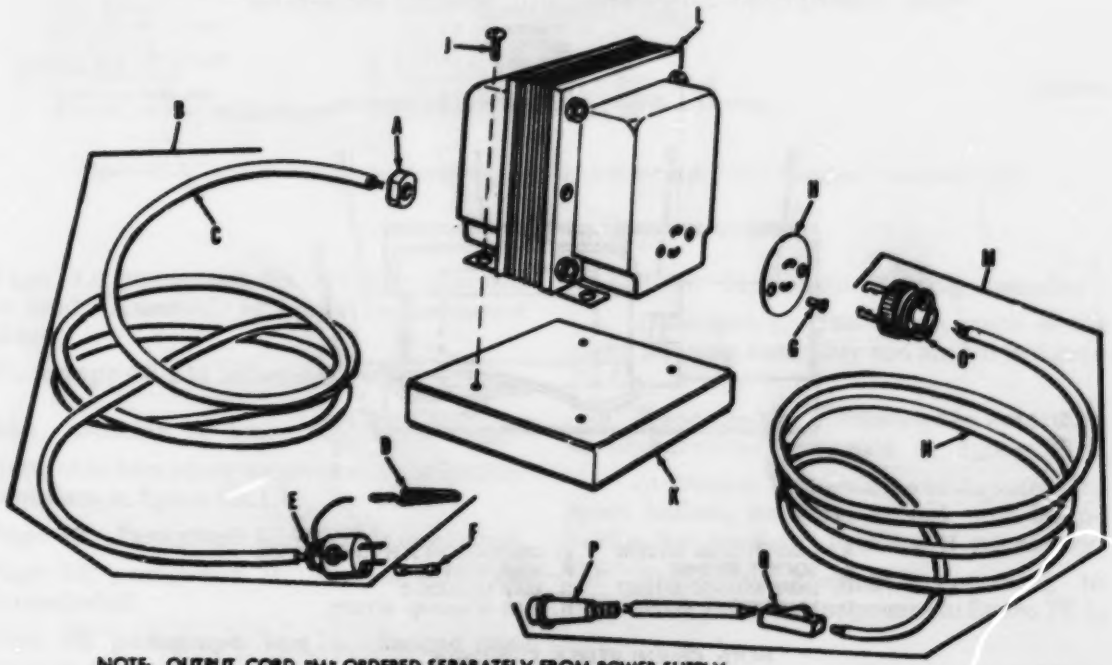
c. Disassembly. Disassemble according to alphabetical sequence in figure 79.

d. Repair. Inspect and replace defective cords, fuse, cables, wires, and plugs. Replace transformer, if defective. Replace toggle switch, if damaged.

e. Assembly. Assemble according to reverse alphabetical sequence in figure 79.

Figure 79 is added as follows:

A. LINE CORD BUSHING 8770775
B. CORD ASSEMBLY 8772995
C. CORD 8772992
D. ELECTRICAL CLIP ALLIGATOR TYPE STYLE-1 W-C-400
E. PLUG 8772993
F. 2 AMP FUSE MIL-F-15160/02
G. NO. 6-32 X 1/4, S, CD-PLTD SCREW MS24629-21
H. FEMALE PLUG 8770782
J. RD-HD NO. 8 X 3/8 WOOD SCREW MS35495-63
K. BASE 8776499
L. TRANSFORMER 8772996
M. CORD ASSEMBLY 8772473
N. OUTPUT CORD 8770496
O. CORD CAP 8770783
P. CONNECTOR PLUG 8770651
Q. TOGGLE SWITCH 8770459



NOTE: OUTPUT CORD "M" ORDERED SEPARATELY FROM POWER SUPPLY OR RETAINED FROM INCANDESCENT POWER SUPPLY.

WE 60306A

Figure 79. Fluorescent power supply assembly — exploded view.

By Order of the Secretary of the Army:

W. C. WESTMORELAND,
General, United States Army,
Chief of Staff.

Official:

KENNETH G. WICKHAM,
Major General, United States Army,
The Adjutant General.

Distribution:

To be distributed in accordance with DA Form 12-37, direct and general support maintenance requirements for self-propelled guns, howitzers, combat tanks, CEV M728 and AR/AAV M551; DA Form 12-40, direct and general support maintenance requirements for weapons in Section 7; and DA Form 12-41, direct and general support maintenance requirements for Borescopes M1 and M2.

*TM 9-4933-200-35

TECHNICAL MANUAL
No. 9-4933-200-35

HEADQUARTERS,
DEPARTMENT OF THE ARMY
WASHINGTON 25, D. C., *12 August 1958*

PULLOVER GAGES, BORESCOPES M1 AND M2, AND PRESSURE GAGE M3

		Paragraphs	Page
CHAPTER 1.	INTRODUCTION		
Section I.	General	1, 2	2
II.	Description	3–6	3
CHAPTER 2.	OPERATING INSTRUCTIONS		
Section I.	Service upon receipt of materiel	7, 8	16
II.	Operation under usual conditions	9–12	17
III.	Operation under unusual conditions	13–17	30
CHAPTER 3.	MAINTENANCE INSTRUCTIONS FOR USING PERSONNEL		
Section I.	Spare parts, tools, and equipment for operation and maintenance	18–21	32
II.	Preventive-maintenance services	22–24	33
III.	Troubleshooting	25–27	34
CHAPTER 4.	FIELD MAINTENANCE INSTRUCTIONS		
Section I.	General	28, 29	35
II.	Parts, special tools, and equipment for field maintenance	30–32	35
III.	Pullover gages	33–36	35
IV.	Final inspection of pullover gages	37, 38	37
V.	Illuminating head assembly for 20-mm guns	39–43	37
VI.	Illuminating head assembly for 37-mm and 40-mm guns	44–48	38
VII.	Small illuminating head assembly for 57-mm through 90-mm weapons	49–53	39
VIII.	Large illuminating head assembly for 105-mm through 280-mm weapons	54–58	41
IX.	Prism illuminating head assembly	59–63	42
CHAPTER 5.	DEPOT MAINTENANCE INSTRUCTIONS		
Section I.	General maintenance	64, 65	45
II.	Borescope M1	66–70	47
III.	Borescope M2	71–77	53
APPENDIX.	REFERENCES	———	60
INDEX		———	62

*This manual supersedes TM 9-1860, 3 December 1942, including C 1, 2 February 1944; and portions of TB 9-1860-2, 29 November 1945, including C 3, 21 September 1955, and C 5, 25 June 1956, pertaining to material covered herein.

CHAPTER 1
INTRODUCTION

Section I. GENERAL

1. Scope

a. It is the purpose of this series of manuals, as listed in *b* below, to give the latest information and instructions for inspecting cannon tubes to the ordnance personnel concerned with cannon bore inspection. The subjects covered are: theory of erosion and damage in cannon bore, causes and effect, evaluation of erosion, serviceability and condemnation limits, the operation and maintenance of bore inspection devices, and pressure gage M3.

b. The appendix contains a list of current references, including supply manuals, forms, technical manuals, and other available publications applicable to the pullover gages, borescopes, and pressure gage M3.

c. This first edition is published in advance of complete technical review. Any errors or omissions will be brought to the attention of the Commanding Officer, Raritan Arsenal, Metuchen, N. J., ATTN: ORDJR–CPRA, using DA Form 468 (Unsatisfactory Equipment Report).

d. This manual is one of a series relating to cannon bore inspection. The other technical manual is TM 9–1000–202–35, Operating Principles: Evaluation of Cannon Tubes (when published).

2. Forms, Records, and Reports

a. General. Responsibility for the proper execution of forms, records, and reports rests upon the officers of all units maintaining this equipment. However, the value of accurate records must be fully appreciated by all persons responsible for the compilation, maintenance, and use. Records, reports, and authorized forms are normally utilized to indicate the type, quantity, and condition of materiel to be inspected, to be repaired, or to be used in repair. Properly executed forms convey authorization and serve as records for repair or replacement of materiel in the hands of troops and for delivery of materiel requiring further repair to ordnance shops in arsenals, depots, etc. The forms, records, and reports establish the work required, the progress of the work within the shops, and the status of the materiel upon completion of its repair.

b. Authorized Forms. The forms generally applicable to units operating this materiel are listed in the appendix. For a listing of all forms, refer to DA Pam 310–2. For instructions on use of these forms, refer to FM 9–10.

c. Weapon Record Book. Procedures and precautions to be observed by responsible personnel in the recording of pertinent data in the Weapon Record Book (DA Forms 9–13 and 9–13–1) (formerly, 00 Form 5825) and instructions relative to its disposition are contained in AR 750–1000–8. See also the printed instructions in the Weapon Record Book.

d. Field Reports of Accidents. The reports necessary to comply with the requirements of the Army safety program are prescribed in detail in AR 385–40. These reports are required whenever accidents involving injury to personnel or damage to materiel occur.

e. Report of Unsatisfactory Equipment or Materials. Any deficiencies detected in the equipment covered herein, which occur under the circumstances indicated in AR 700–38, should be immediately reported in accordance with the applicable instructions in cited regulation.

Section II. DESCRIPTION

3. Purpose

Pullover gages and borescopes are furnished for the purpose of locating and evaluating the extent of erosion and damage in a cannon bore. These instruments make it possible to identify type and degree of erosion or damage and thereby offer a means of evaluating and estimating the life and ballistic accuracy of a weapon. The pressure gage M3 is used to obtain the maximum pressure developed in firing a weapon.

4. Pullover Gage

The pullover gage (figs. 1 and 2) is used to measure the wear of the bore diameter of all types of artillery weapons (37-mm through 280-mm). It is a rugged accurate gage designed for use in the field. The gage employs a vernier type slide that is calibrated in thousandths of an inch from the standard size of the bore being measured. The components of the pullover gage are described in *a* through *d* below.

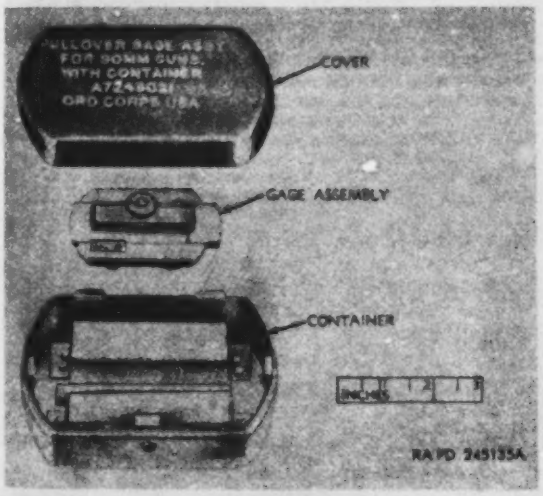


Figure 1. Pullover gage assembly for 90-mm guns w/container.

a. Spring. The spring is used to hold the slide in position. A tee screw having two sides milled flat is inserted through the body, slide,

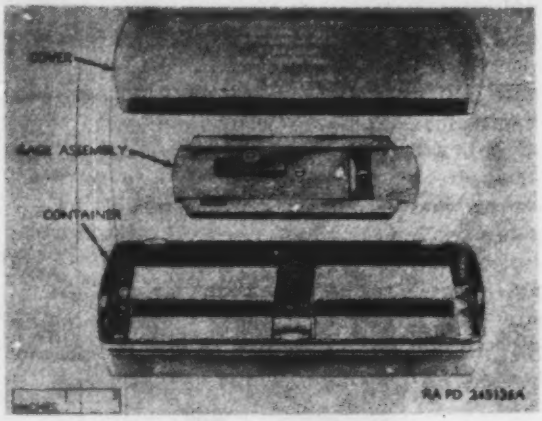


Figure 2. Pullover gage assembly for 8-inch weapons w/container.

and spring and held in place by a knurled adjusting nut.

b. Body and Slide Assembly. The body and slide assembly contains the components necessary for measuring the bore diameter. The slide is located in the channel of the body. It is engraved with a scale which is marked in 0.1-inch divisions and subdivided in 0.025-inch intervals. The vernier scale, attached to the body, is marked in 0.005-inch divisions and subdivided in 0.001-inch intervals, thus allowing measurements of one 0.001 inch.

c. Hinge. Two hinges are attached to the body by pins and are used to rotate the gage in the cannon bore. The hinges are provided with male type threaded ends.

d. Accessories.

(1) *Rod.* Rods (figs. 3 and 4) are furnished in pairs and consecutive pairs and are connected to the hinges of the pullover gage. The rods are available in two sizes, $\frac{3}{8}$-inch and $\frac{5}{8}$-inch diameter. Both are 30 inches in length. These rods are graduated consecutively every inch, with $\frac{1}{4}$-inch subdivisions.

(2) *Stop.* A stop (figs. 4 and 5) is furnished in length suitable for each bore. The stop length is designed to allow measurements to be taken from

the face of the tube inside the breech recess. Each stop is equipped with a clamp to allow it to be set at the proper distance on the lower rod.

5. Borescope

The borescope is used to visually inspect the cannon bore of all types of artillery weapons

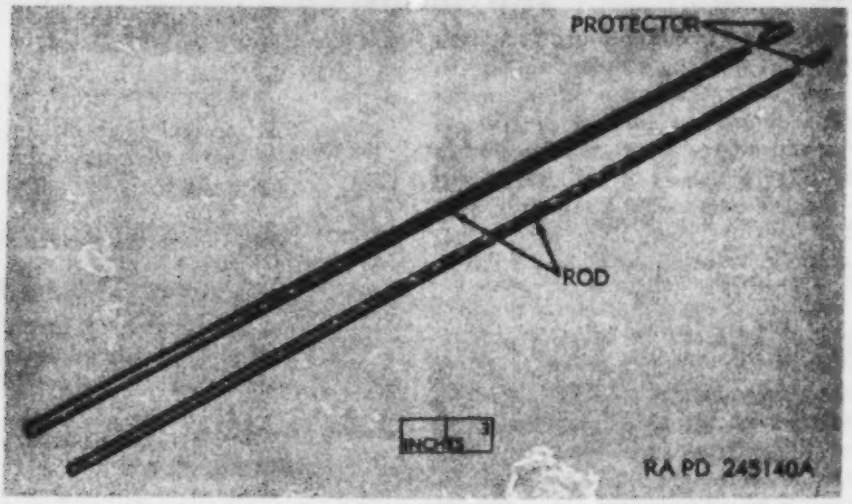


Figure 3. Pullover gage rods.

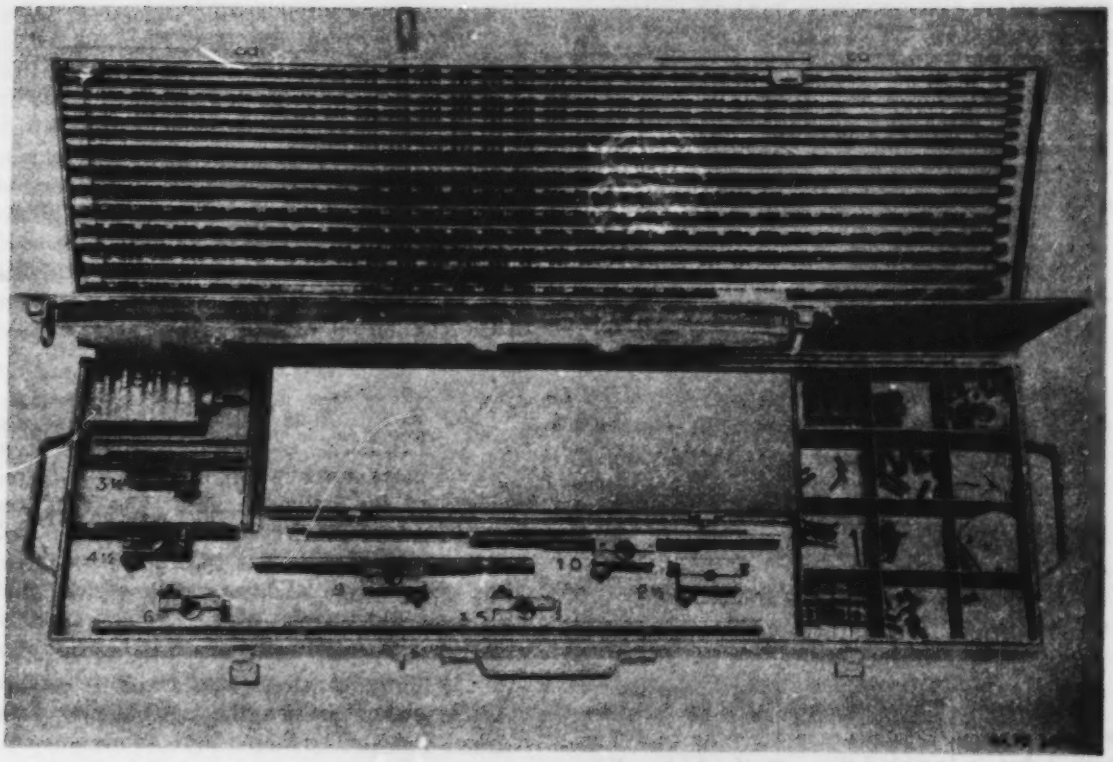


Figure 4. Pullover gage accessories.

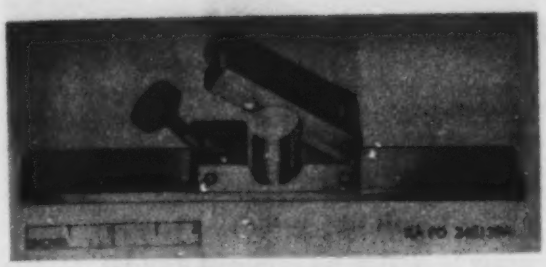


Figure 5. Pullover gage stop.

(20-mm through 280-mm) for defects of manufacture and damage caused by firing. The borescope is available in two models, the M1 and the M2. The borescope M1 (figs. 6 and 7) is used for inspecting cannon bores 20-mm through 40-mm. The borescope M2 (figs. 8 and 9) is used for inspecting cannon bores 57-mm through 280-mm. Both devices are basically a straight-tube telescope using a mirror (mirror or prism for borescope M2) set at an angle to present a view of the bore being inspected.

a. Borescope M1. Borescope M1 is composed of the items described in (1) through (4) below.

(1) *Eyepiece assembly.* This assembly (figs. 6 and 10) is located on the viewing end of the instrument. A rubber eyeshield is provided to form a light block. Focal adjustment is obtained through operation of either of the two larger knurled knobs. A knurled head screw is provided to lock the assembly in focus. The outside of the barrel incorporates on annular groove into which spring loaded ball detents in the borescope tube assembly seat to prevent the eyepiece assembly from falling out of the borescope tube and to keep the image in focus.

(2) *Borescope main tube assembly.* This assembly (figs. 6 and 11) contains all the optical elements incorporated in the borescope other than in the eyepiece assembly. The collector assembly, located on the borescope tube, provides the electrical connection between the lamp in the illuminating head and the transformer. The tube is free to revolve in the collector assembly and still maintain the electrical connections. The outside of the tube is graduated in 1-inch intervals. Every fifth line is numbered. These lines are arranged so that they indicate the distance from the center of the area being viewed in the weapon tube to the edge of the opening into which the instrument was inserted. It is also engraved the full length with a longitudinal line for the purpose of indexing the borescope properly.

(3) *Illuminating head assembly.* The illuminating heads are furnished in two sizes, one for the 20-mm weapons (figs. 6 and 12) and one for the

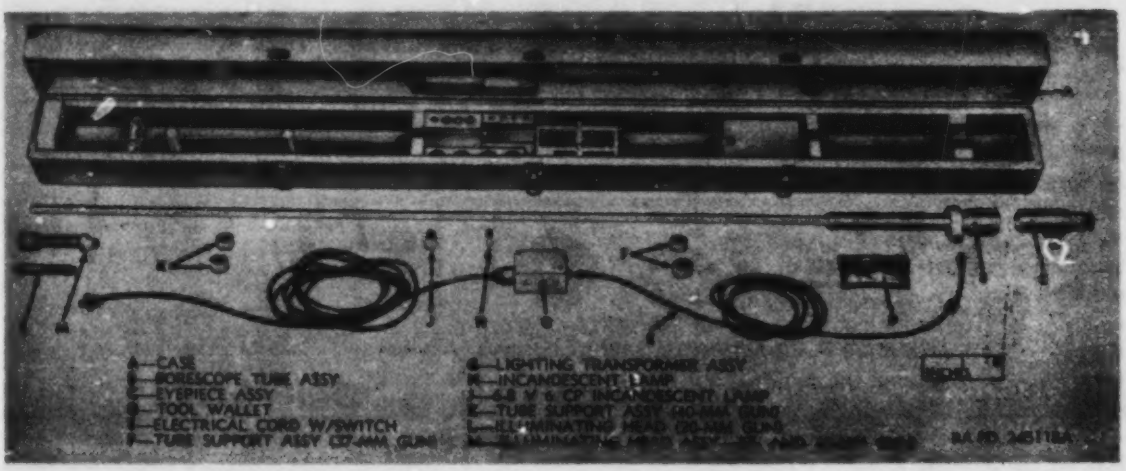


Figure 6. Borescope M1 w/equipment.

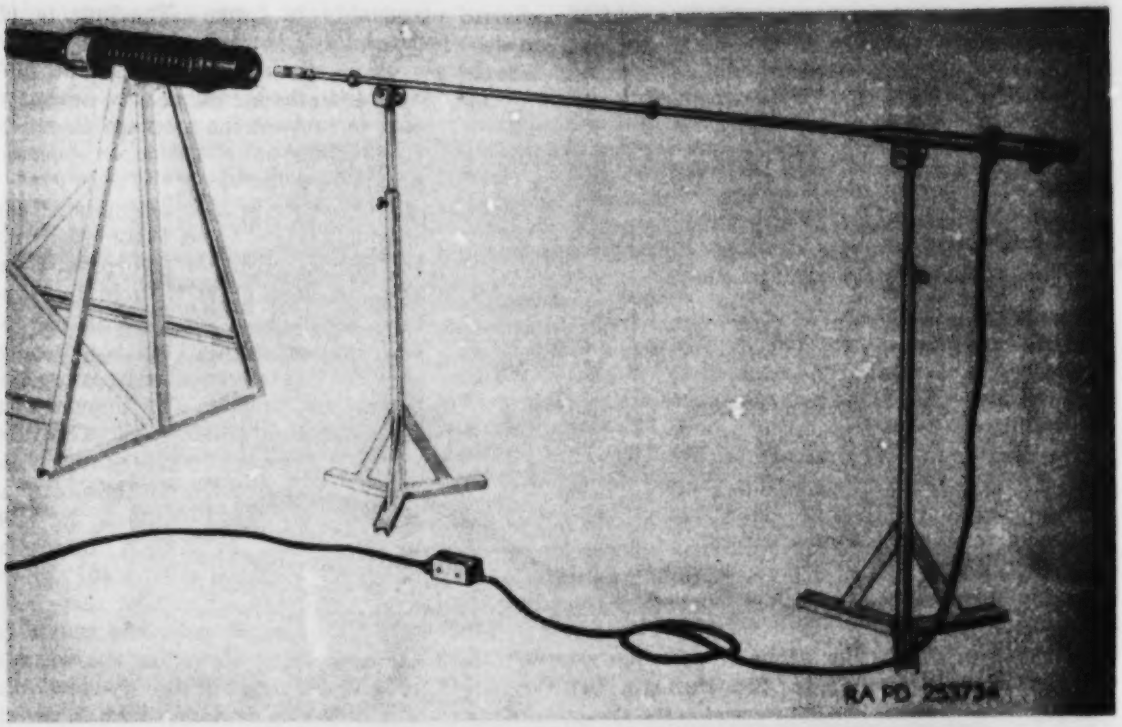


Figure 7. Borescope M1 assembled to inspect 40-mm gun.

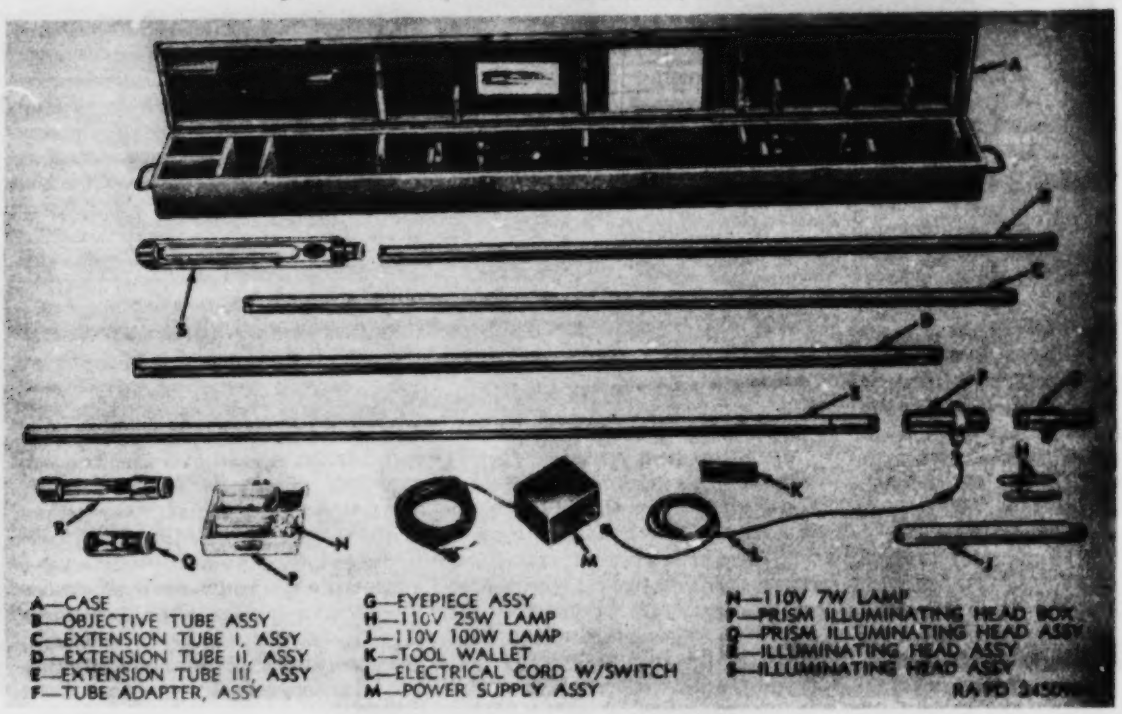


Figure 8. Borescope M2 w/equipment.

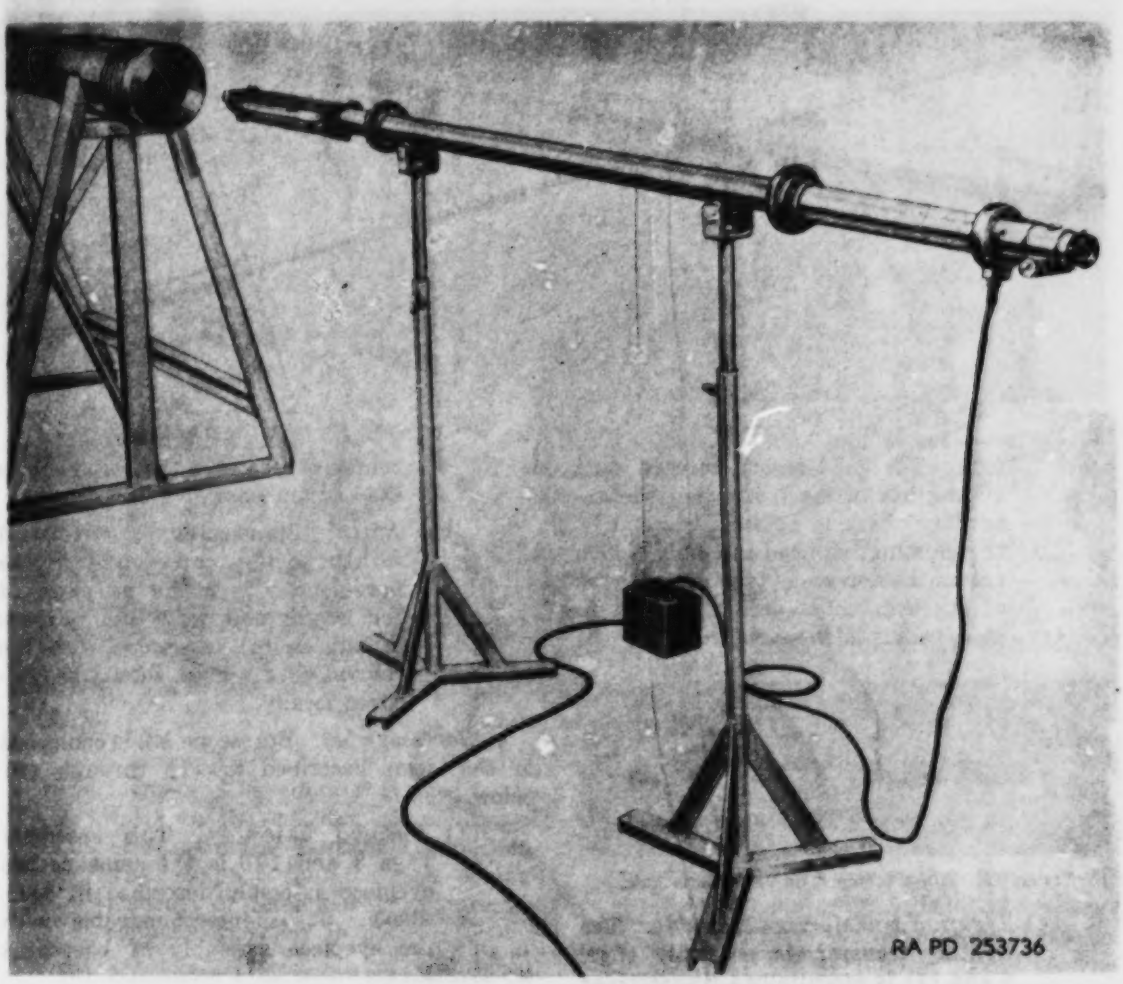


Figure 9. Borescope M2 assembled to inspect 105-mm howitzer.

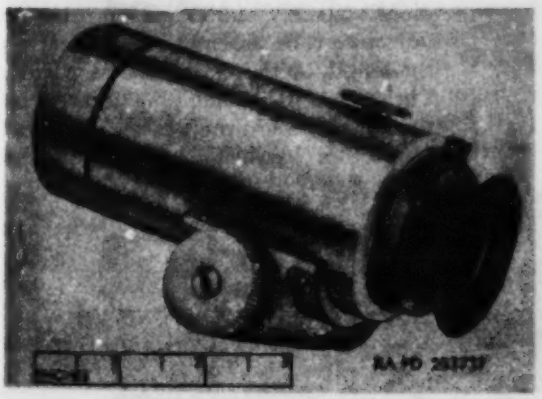


Figure 10. Eyepiece assembly.

37-mm and 40-mm weapons (figs. 6 and 13). These heads contain two mirrors. One mirror bends the optical path so that the bore of the tube in which the borescope is inserted will be viewed. The other mirror reflects the light from the lamp contained in the head to the section of the tube bore being observed. On the 20-mm head, the lamp screws into the end of the illuminating head. This is to facilitate removal of the lamp for replacement purposes. The lamp assembly on the 37-mm and 40-mm illuminating head is secured in the end by a hidden version of the bayonet

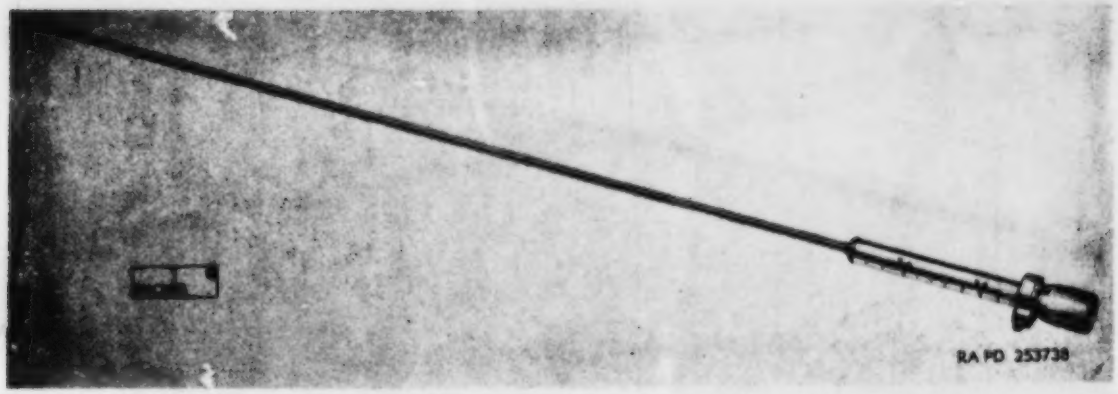


Figure 11. M1 borescope tube assembly.

lock. The head assemblies are snug sliding fits in the borescope tube assembly. This is because the end of the illuminating head assembly, which enters the borescope tube assembly, is of the split collet design, locking in place when fully seated.

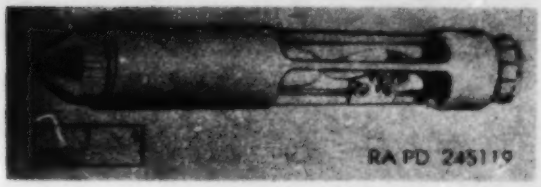


Figure 12. Illuminating head for 20-mm gun.

(4) *Lighting transformer assembly.* The lighting transformer assembly (figs. 6 and 14) is essentially a transformer which converts 110-volt 60-cycle current to 6.3 volts. The transformer is contained in a housing with required leads and plugs (cord assemblies). One lead is the conventional two-prong type used with 110-volt electrical equipment. The other lead has a connector with a clamping ring. This connector attaches to the collector housing on the borescope.

(5) *Accessories.*

(*a*) *Support.* Supports (figs. 6 and 15) are furnished for the 37-mm and 40-mm weapons. They are essentially collars which are slipped over the borescope and held in place by setscrews. Supports are used to center and balance the borescope in the cannon bore.

(*b*) *Stand.* Stands (fig. 16) are used for supporting the weight of the borescope. They can be adjusted for height and serve the purpose of alining the borescope with the cannon bore. They should be procured locally.

b. Borescope M2. Borescope M2 is composed of the items described in (1) through (6) below.

(1) *Eyepiece assembly.* This assembly (figs 8 and 10) is the same as the eyepiece assembly described in *a*(1) above. It is interchangeable with the eyepiece assembly of borescope M1.

(2) *Adapter tube assembly.* This assembly (figs. 8 and 17) connects the eyepiece assembly and extension tubes or objective tube assembly depending on the length of the bore to be inspected. The collector assembly is located on the adapter and provides the electrical connection between the lamp in the

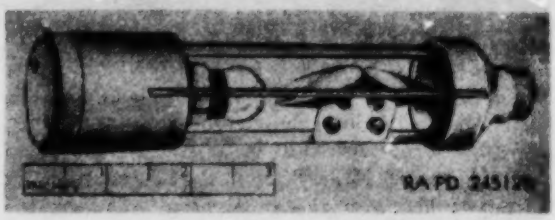


Figure 13. Illuminating head for 37-mm and 40-mm weapons.

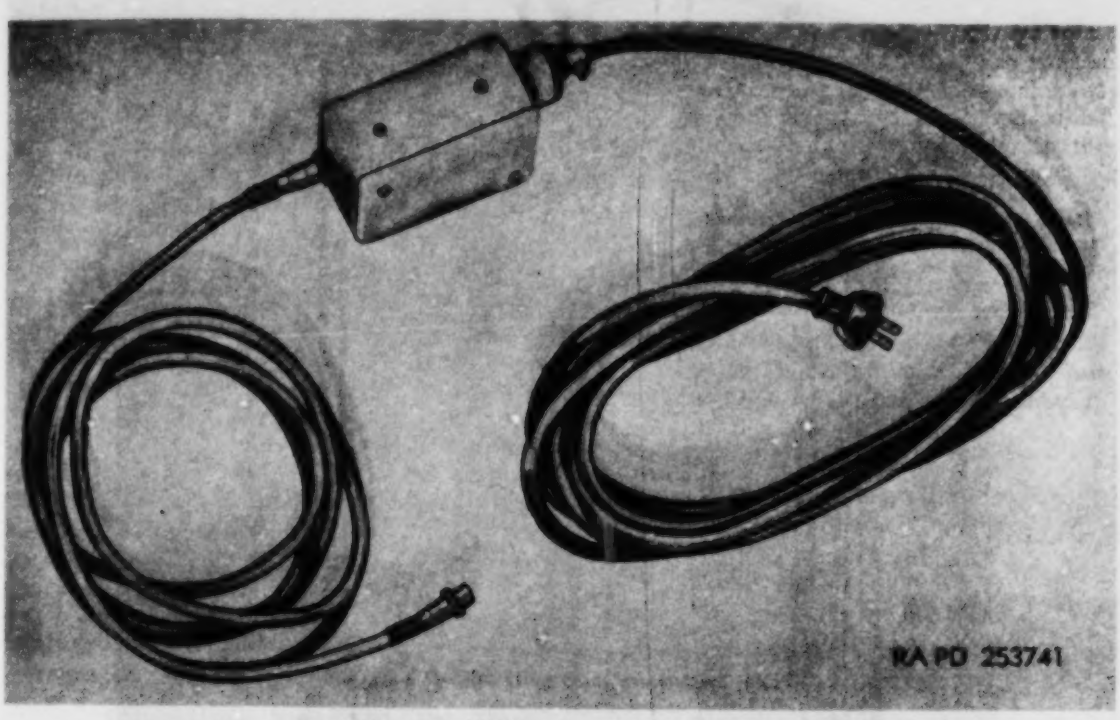


Figure 14. Lighting transformer assembly.

illuminating head and the transformer. The adapter is free to revolve in the collector assembly and still maintain electrical connection. The adapter contains the spring-loaded ball detents which secure the eyepiece assembly in place.

(3) *Extension tube assembly.* Three extension tubes (figs. 8 and 19) are provided to extend the range of the borescope to cover the various weapon lengths encountered. These tubes permit inspection of all but the largest weapons. The tubes are numbered with Roman numerals (I, II, and III). These tubes relay the view to the operator and do not magnify. The only difference in the tubes is the graduations on the outside of the barrel. The order of assembly between the objective tube assembly and adapter tube assembly is tube I, tube II, and tube III. These tubes have bayonet locks on one end and a spring-loaded sliding latch on the other end. The end with the sliding latch has two pins for locking in the bayonet slots of the next tube.

(4) *Objective tube assembly.* The objective tube assembly (figs. 8 and 19) contains the lenses that focus on the mirror or prism. This tube always connects to the illuminating head for use. The end of this tube that connects to the illuminating head contains two bayonet locks. The opposite end contains a spring-loaded sliding latch. The end with the latch has two pins for locking in the bayonet slots of the next tube. The outside surface of the tube is graduated in 6-inch and 1-foot intervals. The 1-

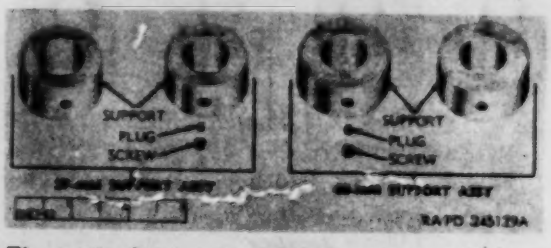


Figure 15. Borescope supports for 37-mm and 40-mm weapons.

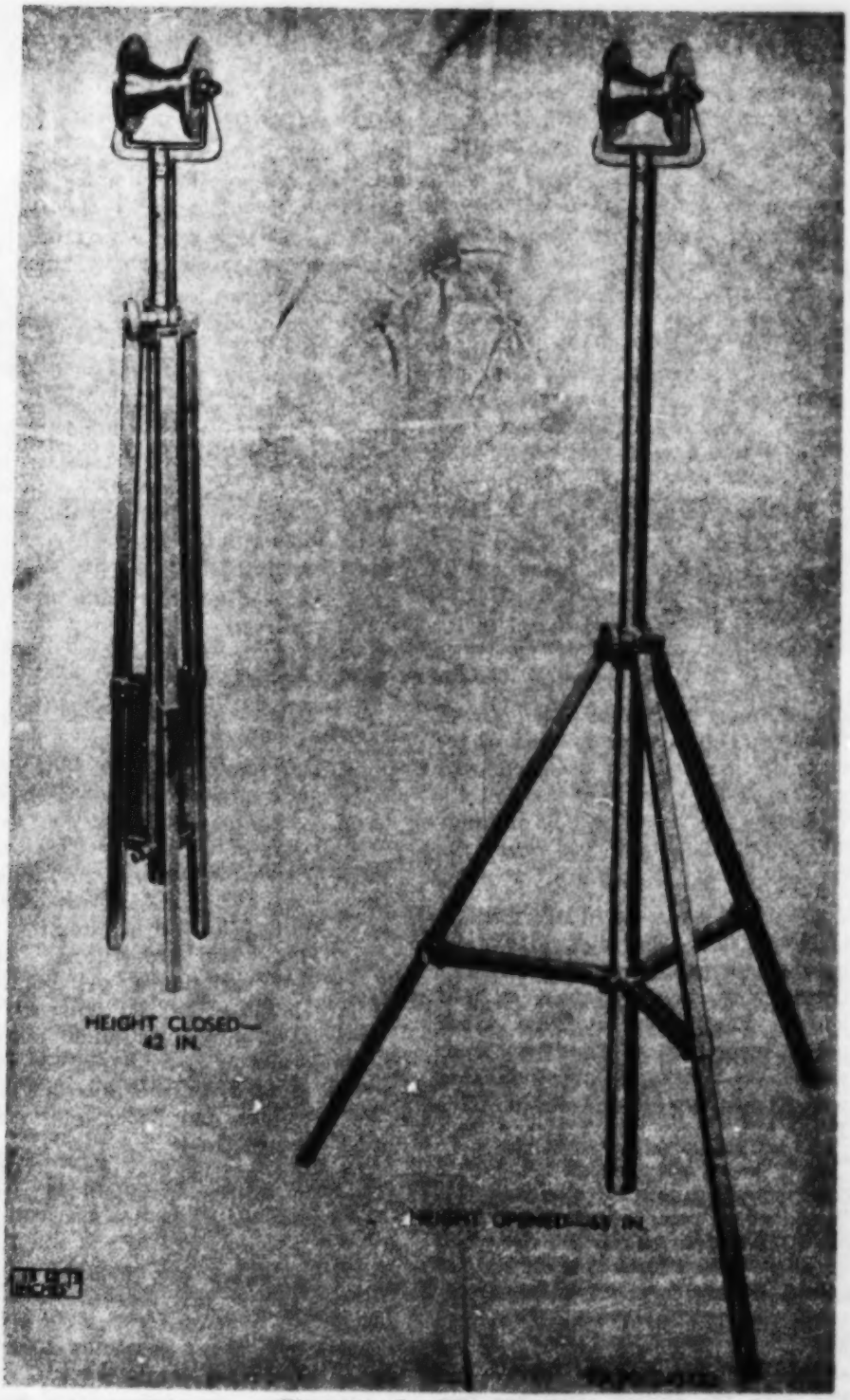


Figure 16. Borescope stand.

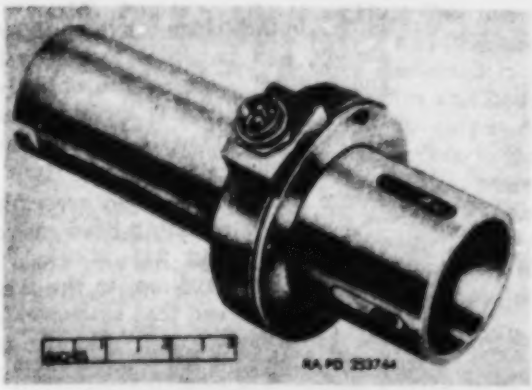


Figure 17. Adapter tube assembly.

foot lines encircle the tube and are numbered consecutively. The outside surface of the tube is also engraved the full length with a longitudinal line for the purpose of indexing the borescope properly.

Note. Optical examination of materiel with this assembly will reverse reference views. Care should be used in expressing o'clock position.

(5) *Illuminating head assembly.* The illuminating head assembly is furnished in three sizes as designated in (*a*) through (*c*) below.

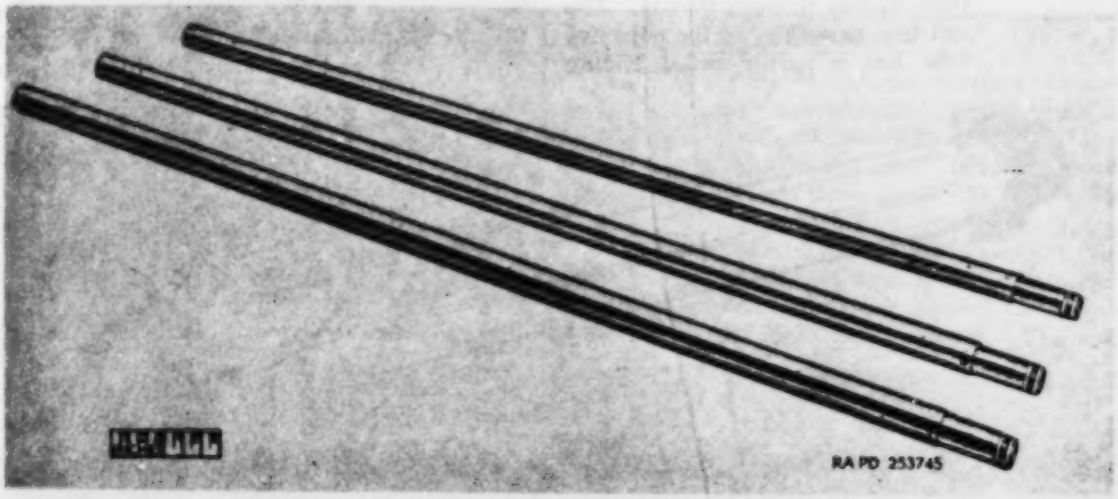


Figure 18. M2 borescope extension tube assemblies.

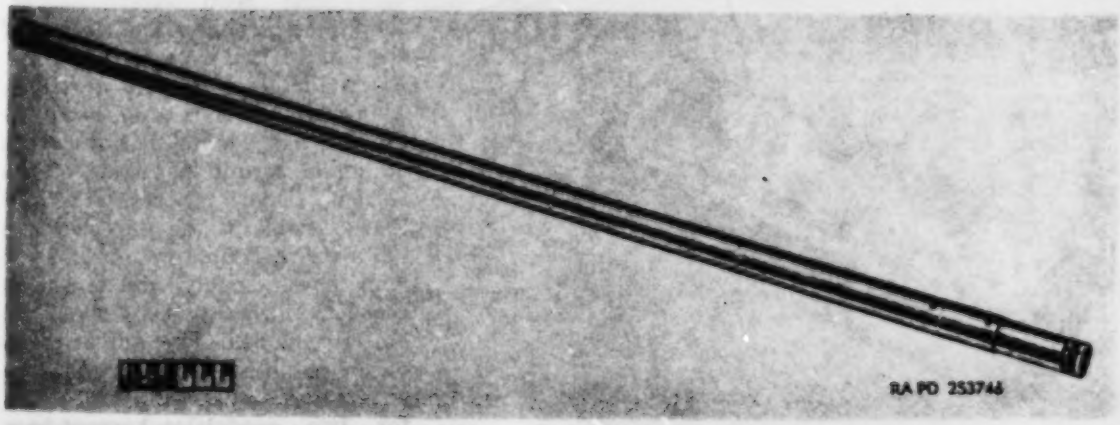


Figure 19. M2 borescope objective tube assembly.

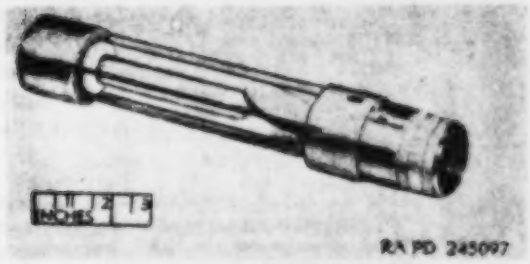


Figure 20. Small illuminating head assembly for 57-mm through 90-mm weapons.

(a) *Small illuminating head assembly.* The small illuminating head assembly (figs. 8 and 20) has a fixed mirror. This head is used in weapons from 57-mm through 90-mm. The end that assembles to the objective tube has a spring-loaded sliding latch, contact rings for lamp power supply, and two pins that lock in the bayonet slots of the objective tube. The mirror is set at a fixed angle. The lamp is of the long tubular type.

(b) *Large illuminating head assembly.* The large illuminating head assembly (figs. 8 and 21) is used in weapons from 105-mm to the largest size. The end that assembles to the objective tube has a spring-loaded sliding latch, contact rings for lamp power supply, and two pins that lock in the bayonet slots of the objective tube. The mirror mounts on a wide field of view ranging from a point ahead of the lamp, to an area almost at right angles to the tube centerline. The lamp is of the long tubular type.

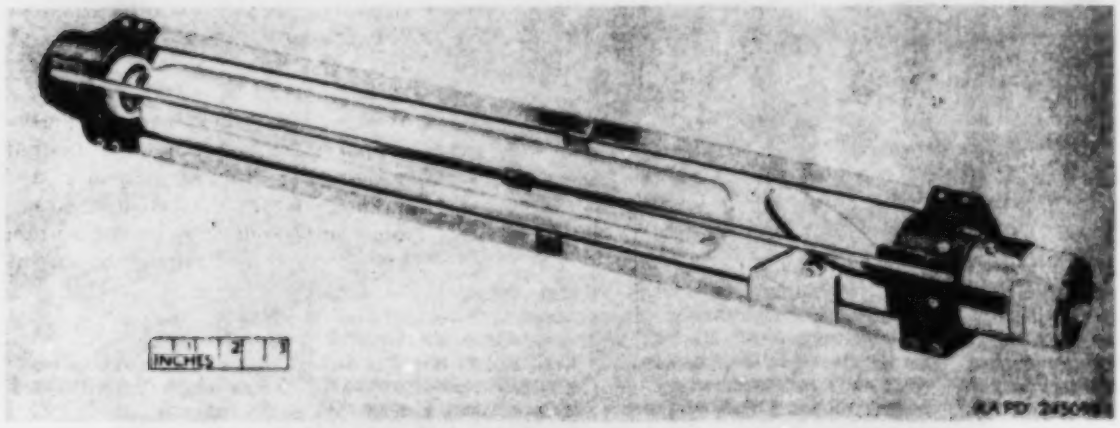


Figure 21. Large illuminating head assembly for 105-mm through 280-mm cannon.

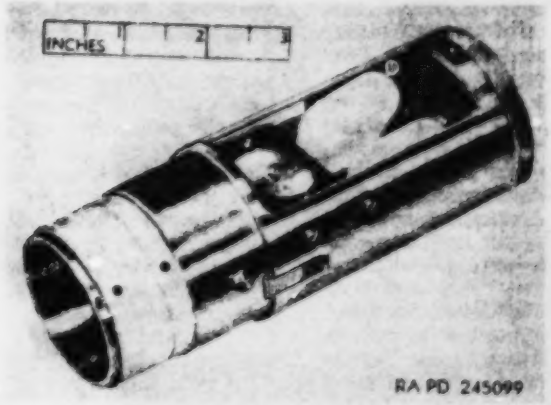


Figure 22. Prism illuminating head assembly.

(c) *Prism illuminating head assembly.* This prism illuminating head assembly (figs. 8 and 22) is of a short design to permit inspection of the bottom of mortar bores. The end that assembles to the objective tube has a spring-latch, contact rings for lamp power supply, and two pins that lock in the bayonet slots of the objective tube. The mirror is a prism mounted at a fixed angle on a mount that serves as the socket for two candelabra-bayonet-base lock lamps.

(6) *Power supply assembly.* The power supply assembly (figs. 8 and 23) is an isolating transformer contained in a box with the required plugs and leads. This transformer has an output of 110 volts 60 cycles and serves to isolate the operator from the power source, thereby, eliminating the chances of shock. One lead is the conventional two-prong type used in 110-volt electric equipment and incorporates a third wire with an alligator type clamp for grounding purposes. The other lead has a connector with a clamping ring. This connector attaches to the collector housing on the borescope. It is also provided with a single-pole switch for safety purposes and ease of operation.

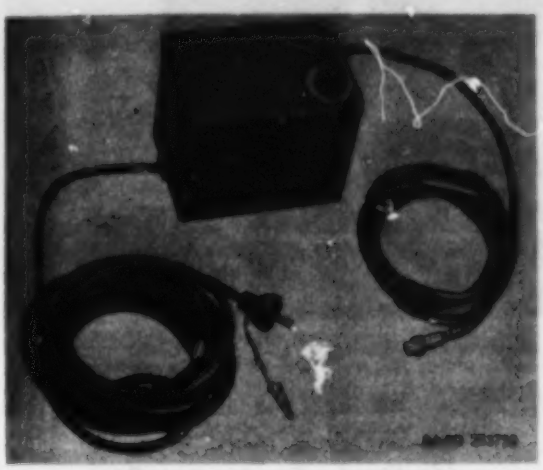


Figure 23. Power supply assembly.

(7) *Accessories.*

(*a*) *Adapter assembly.* The adapter assembly (fig. 24) is issued to adapt the supports (90-mm through 280-mm) to the borescope. The assembly is composed of a split collet with knurled shoulder which is slipped over the borescope tube and is threaded to receive a knurled collar and nut.

(*b*) *Support.* Supports (figs. 24 and 25) are provided for all types of artillery weapons from 57-mm through 280-mm. They are available in three types: the split sleeve support for 57-mm and 60-mm bores; the hinged support for 75-mm, 76-mm, and 81-mm bores; and the washer support for 90-mm through 280-mm bores. The split

Figure 24. M2 borescope supports and adapter assembly.

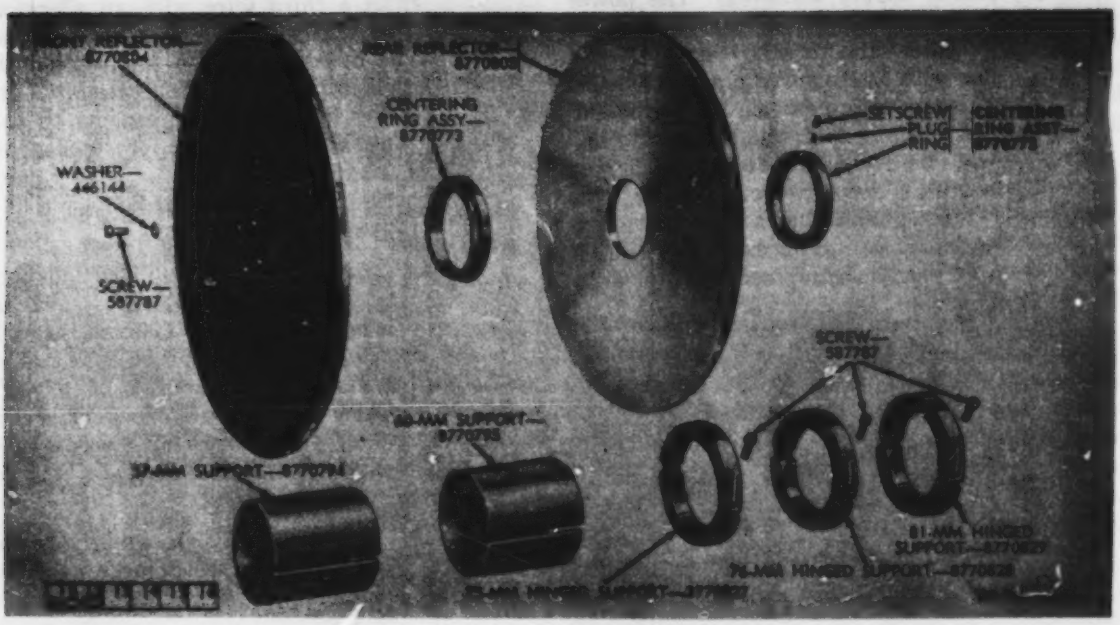


Figure 25. M2 borescope supports and reflectors.

sleeve support is slipped over the borescope tube and held in place by its spring action; the hinge support is clamped to the borescope tube and held in place by screws; and the washer support is slipped over the adapter assembly and held in place by the knurled surface of the adapter assembly. The purpose of the supports is to center and balance the borescope in the cannon bore.

(*c*) *Reflector.* Two reflectors (fig. 25) are issued for inspecting the bore of the 280-mm weapons. These reflectors are painted white on one side and black on the opposite side. One reflector is secured to the large illuminating head by screws in such a manner that the white surface is in contact with the illuminating head. The other reflector, with its white side facing the white side of the reflector attached to the illuminating head, is secured to the objective tube assembly by means of two centering rings. These reflectors are provided to concentrate the light on the area being inspected.

(*d*) *Stand.* Stands are used for supporting the weight of the borescope. They should be adjustable for height to provide a means of alining the borescope with the cannon bore. They should be procured locally. Figure 16 illustrates a suitable stand.

6. Pressure Gage M3

The crusher-type pressure gage M3 consists essentially of a steel cap, a copper gas-check cup, and a steel housing that contains a steel piston and a copper cylinder. The steel cap closes the housing at one end and the gas-check cup closes the other end. The piston area of the M3 gage is $\frac{1}{10}$ square inch. When the powder charge ignites, the pressure of the rapidly expanding gases is exerted against the gas-check cup. This pressure is transmitted to the steel piston causing it to move and compress the copper cylinder against the steel cap. The compression of the cylinder, difference in height before and after firing, is measured in one ten-thousandths of an inch with a microm-

eter caliper. The compression depends on the maximum powder pressure in the powder chamber. It may be expressed in terms of pressure by reference to tarage tables which are empirical tables relating the gas compression of copper cylinders to the static pressure that produces this compression. Representative samples of copper cylinders are subjected to various pressures in a hydraulic press for 15 seconds and the corresponding pressures are plotted as a curve. From this curve, tarage tables are prepared. The pressures obtained with the M3 gage are considered about 80 percent of actual maximum pressure. The probable error of an average pressure is 600 psi plus.

CHAPTER 2

OPERATING INSTRUCTIONS

Section I. SERVICE UPON RECEIPT OF MATERIEL

7. General

a. When a new or reconditioned pullover gage or borescope is received by the using organization, it is necessary for those responsible for its use to determine that the materiel is complete and has been properly prepared by the supplying organization.

b. A record should be made of all missing parts and any malfunctions. Any such conditions should be reported and corrected as quickly as possible. Report receipt of damaged or improper shipment on DD Form 6.

c. The instruments should be cleaned and prepared for service in accordance with instructions given in paragraph 8.

8. Services

a. Pullover Gage.

(1) Remove pullover gage from its container and apply a light film of oil on all finished surfaces to prevent corrosion.

(2) Release the pressure on the spring and check the slide assembly for ease of movement.

(3) Check the general condition and appearance of the gage. Inspect the gage for imperfections, such as burs and nicks, which may result in incorrect measurements. Check for loose, broken, or missing pins or screws. Inspect adjusting screw, nut, and hinges for evidence of rust.

(4) Remove rust and apply oil to the part.

(5) Check accessories with Department of the Army Supply Manual SM 9–4-series.

b. Borescope.

(1) Remove borescope from its case and assemble it. See paragraphs 11 and 12 for instructions.

(2) Wipe all exposed surfaces clean, the outside surface of the tubes, the outside of the contact ring ends, and the inside of the connecting ends. Only the exposed lenses will be cleaned. This will be accomplished only with the use of lens tissue. Do not apply oil to any surface. Oil is not required to preserve this instrument as the borescope is manufactured from nonferrous metals and stainless steel. Oil is used only on the split collets of the borescope M1 illuminating heads for lubricating purposes.

(3) Inspect all electrical contacts for loose or broken connections.

(4) Inspect all connecting parts for ease of assembly. Check for nicks or burs on mating surfaces.

(5) Check eyepiece controls for ease of operation.

(6) Inspect cord assemblies for loose or broken connections and broken, frayed, or exposed cables.

(7) Check the illuminating head mirrors for nicks or scratches.

(8) Connect the borescope to the power source and check the illuminating heads and spare lamps.

(9) Check the general condition and appearance of the borescope. Inspect for dents in the tubes which may damage the internal components.

(10) Check the borescope to insure that it is optically correct.

(11) Check accessories with the Department of the Army Supply Manual SM 9–4-series. Inspect for completeness and serviceability.

Section II. OPERATION UNDER USUAL CONDITIONS

9. General

This section contains instructions for the mechanical steps necessary to operate the pullover gages and borescopes under conditions of moderate temperature and humidity. Instructions for operation under unusual conditions are given in paragraphs 13 through 17.

10. Operation of Pullover Gage

a. Assembling Operations. Select the required pullover gage assembly from table I and remove it from the container (a separate pullover gage is required for each size bore). Determine the number of rod assemblies necessary for the cannon to be measured (table II) and screw them to the gage hinges. Choose the stop required for the cannon as shown in table III and secure it to the lower rod assembly by use of the stop clamp. The stop should be assembled so that the straight contact surface is toward the gage and so set that the distance predetermined for inspection is indicated by the marking on the rod assembly at the rear of the stop. The distance mark is set from the rear of the stop in order to compensate for the measuring surface of the gage being 1 inch ahead of the end of the rod assembly.

b. Setting the Gage. Release the adjusting nut holding the spring and slide and set the slide approximately 0.3- to 0.4-inch larger than the basic diameter of the bore. Tighten the adjusting nut sufficiently to prevent the slide jarring easily out of position while being inserted and removed from the cannon.

c. Inserting the Gage in the Bore. Holding the gage vertical and the slide in the upward position, push the upper rod assemblies forward until the gage is tilted approximately 40° (fig. 26); insert into the cannon through the chamber until the stop rests against the rear face of the cannon tube (fig. 27).

Note. Readings are taken with the stop resting against the rear face of the cannon tube and not the rear surface of the breech ring.

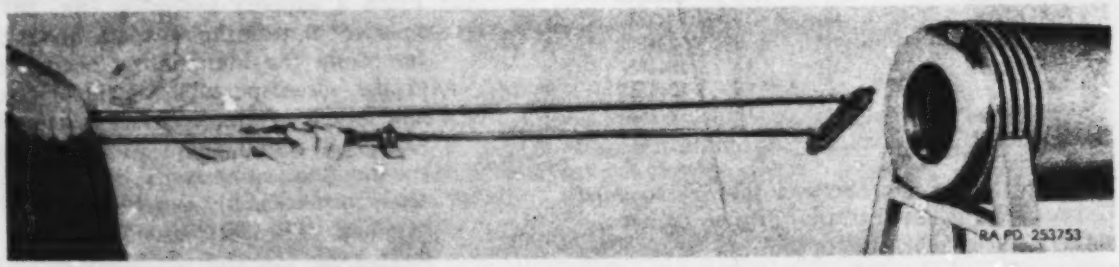


Figure 26. Position of pullover gage before gaging 155-mm cannon.

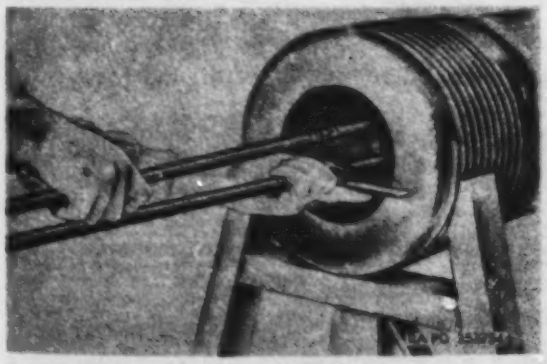


Figure 27. Position of pullover gage during gaging 155-mm cannon.

Table I. Pullover Gages for Artillery Weapon Inspection

Caliber of weapon	Gage assembly w/container part Nos.
37 mm	7242999
40 mm	7243017
57 mm	7243018
75 mm	7243019
76 mm and 3 inches	7243020
90 mm	7243021
105 mm	7243022
120 mm	7243023
155 mm	7243024
8 inches	7243025
280 mm	7243027

Table II. Rod Assemblies for Artillery Weapon Inspection

Caliber of weapon	Rod assembly part No.	No. required
Up to and including 57 mm	7242981	1 pr.
Above 57 mm to and including 76 mm.	7242983	1 pr.
Above 76 mm to and including 120 mm.	7242983	1 pr.
	7242988	1 pr.
Above 120 mm to and including 8 inch.	7242983	1 pr.
	7242988	1 pr.
	7242989	1 pr.
280 mm	7242983	1 pr.
	7242988	1 pr.
	7242989	1 pr.
	7242990	1 pr.

Table III. Pullover Gage Stops for Artillery Weapon Inspection

Caliber of weapon	Stop length	Stop part No.
37 mm	2	7243154
40 mm	3½	7243178
57 mm	3½	7243178
75 mm	4½	7244654
76 mm and 3 inches	4½	7244654
90 mm	6	7243179
105 mm	6	7243179
120 mm	9	7244652
155 mm	9	7244652
8 inches	15	7244653
240 mm	15	7244653
280 mm	15	7244653

d. Centering and Setting the Assembled Gage. With the stop resting firmly against the cannon face, pull the upper rod assemblies rearward until the slide contacts the bore (fig. 28). Check for evenness of contact and for centering and vertical positioning of the gage. Continue a smooth rearward movement of the upper rod assemblies as far as the gage permits (fig. 29). The diameter of the bore at the desired point is now set on the gage. Carefully withdraw the gage from the cannon with the upper rod assemblies in the rearward position (fig. 30). Do not allow the gage to strike the breech or other objects which would change the gage reading. Read the scale of the gage. The actual reading of the vernier scale will be the difference between the designated caliber and the actual bore diameter. The actual bore diameter will then be the caliber of the cannon plus the vernier reading. For a vernier reading of 0.008 inch, the bore diameter of a 90-mm gun (3.543 inches) would be 3.543 plus 0.008 inches or 3.551 inches.

11. Operation of Borescope M1

a. Assembling Operation. Two stands placed about 4½ feet apart are required to hold the borescope during assembly. The steps necessary to assemble the borescope are described in (1) through (5) below. See table IV.

(1) Remove the borescope tube assembly from the case (fig. 32) and place it on the stands (fig. 32).

(2) Place a support assembly (fig. 33), selected to suit the weapon, about 2 feet from the illuminating head end of the borescope tube assembly. Do not secure in place. Place a second support assembly about 3 inches from the illuminating head end of the borescope tube assembly and secure lightly in place. The first assembly will remain near the end of the bore and the borescope will slide through it.

(3) Select the illuminating head assembly required for the weapon (table IV). While holding the borescope tube assembly with one hand, aline

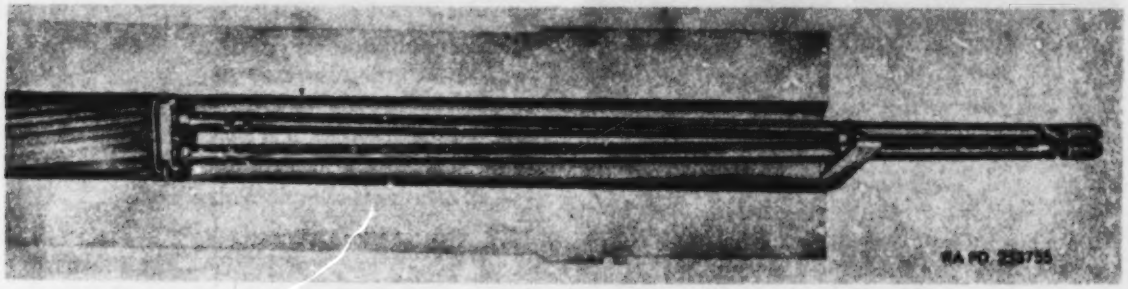


Figure 28. Pullover gage in position.

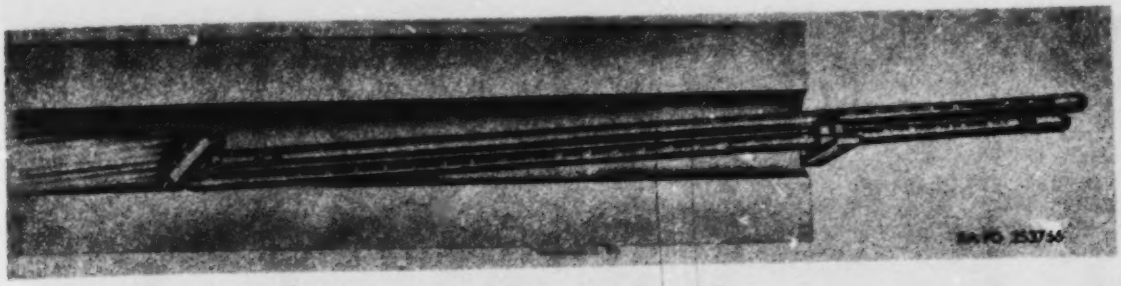


Figure 29. Pullover gage after gaging.

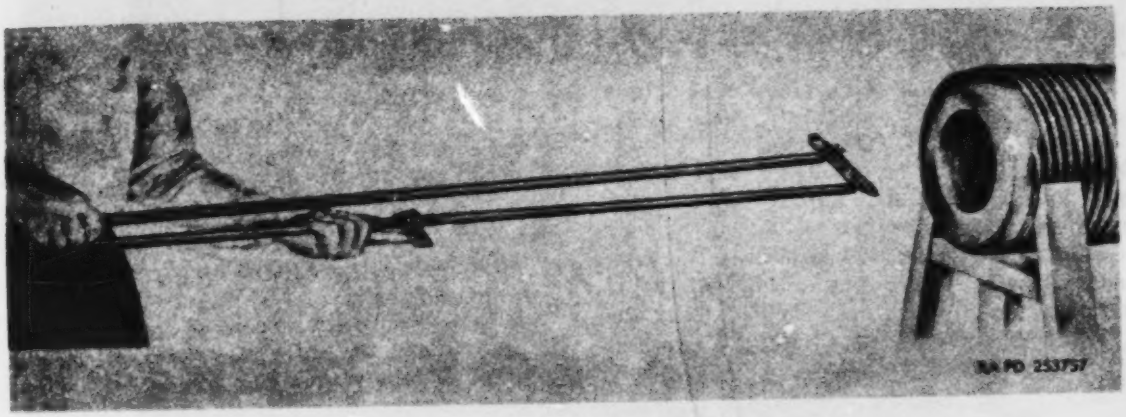


Figure 30. Pullover gage withdrawn from 155-mm cannon.

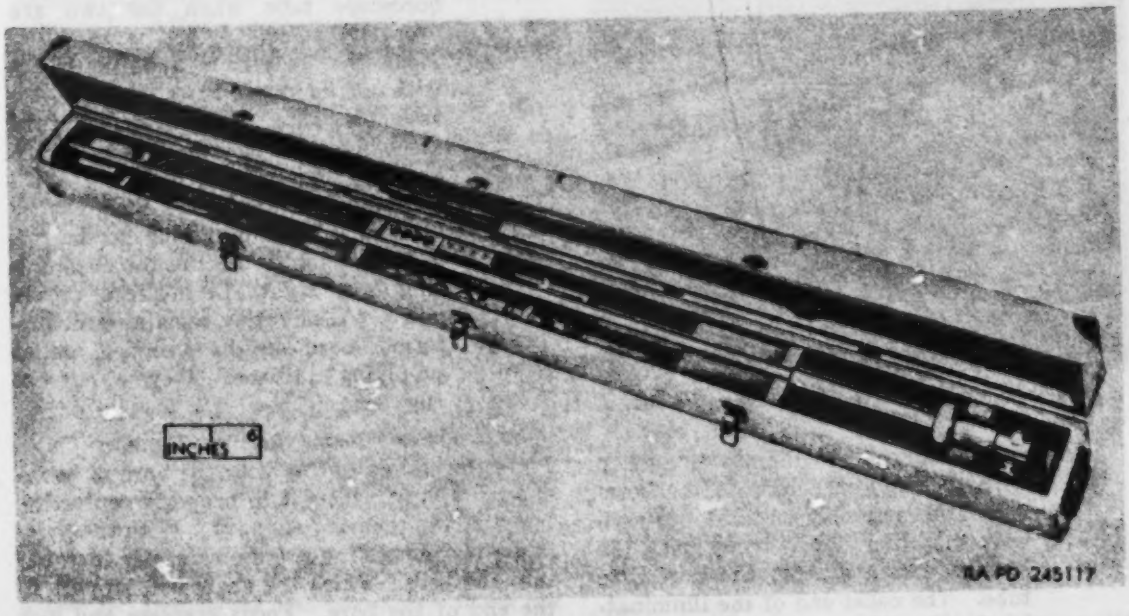


Figure 31. M1 borescope in case.

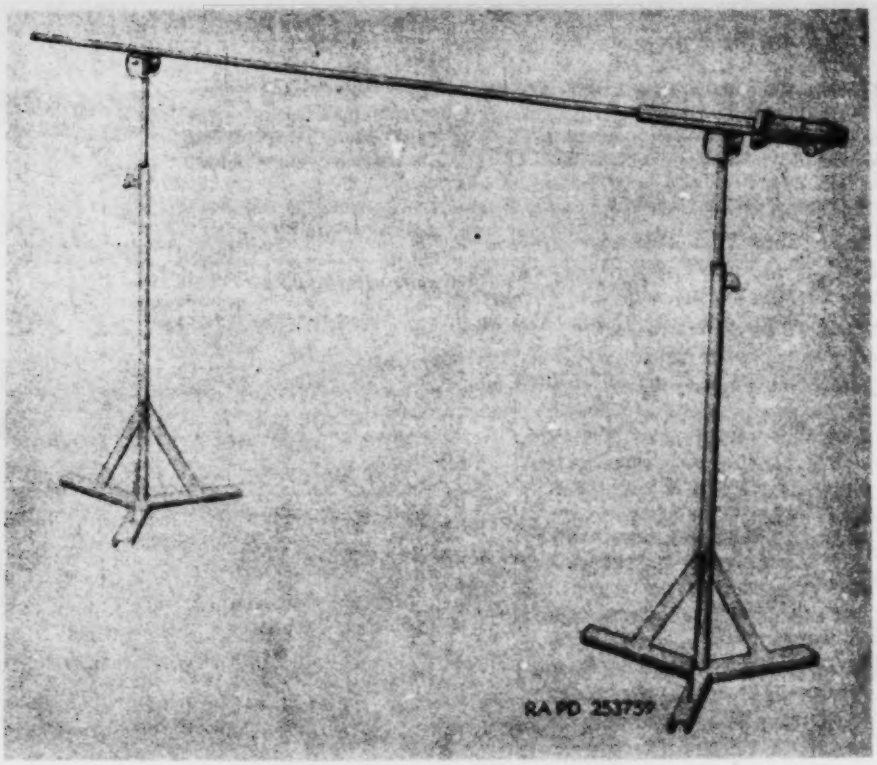


Figure 32. Borescope tube on stands.

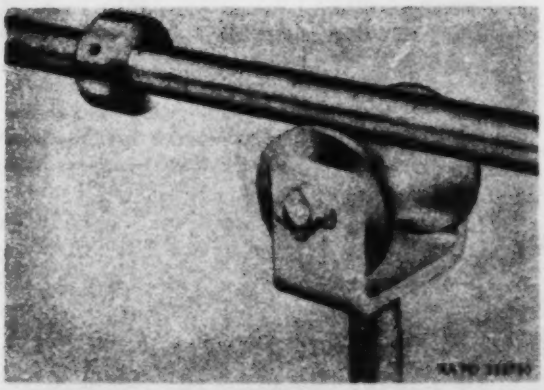


Figure 33. Support installed on borescope M1.

the mirror of the illuminating head with the reference line on the borescope tube assembly (figs. 34–36) and, with the other hand, firmly push the illuminating head into the borescope tube. The collet end of the illuminating head will snap into place in the borescope tube when the two are properly joined.

(4) Hold the borescope tube assembly with one hand and insert the eyepiece assembly into the borescope tube assembly until the ball detents are heard to snap in the groove (fig. 37).

(5) Connect the transformer cord, having the knurled clamping ring, to the collector assembly. Secure the clamping ring finger tight. Do not force or use pliers. Insert the remaining transformer cord on the electrical outlet supplying 110-volt 60-cycle current (fig. 38).

b. Inserting Borescope in Cannon Tube. Place the stands in line with the bore to be inspected and at a height to properly center the borescope in the bore (fig. 39). With the borescope resting on the stands, carefully insert it into the bore. Place the rearmost support in the end of the bore. Focus eyepiece and lock in place (fig. 40). As the bore is examined,

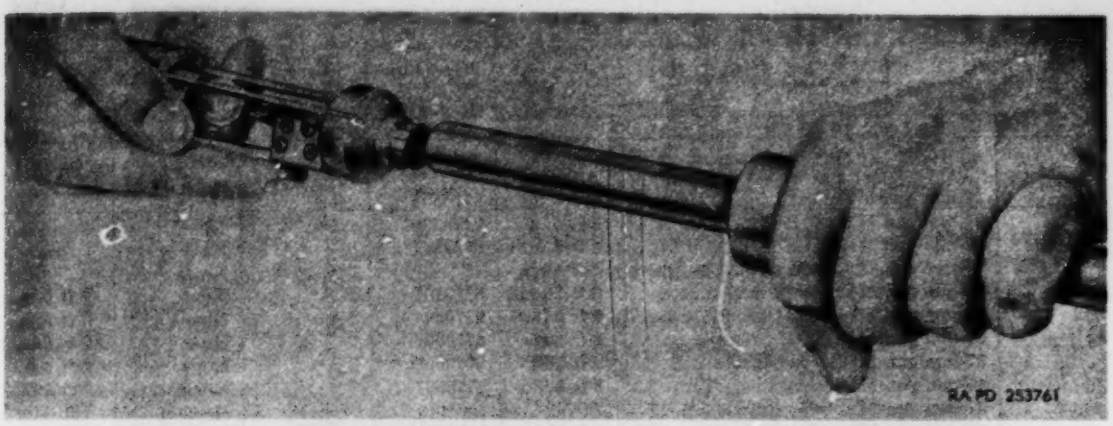


Figure 34. Installing illuminating head assembly for 37-mm and 40-mm guns.

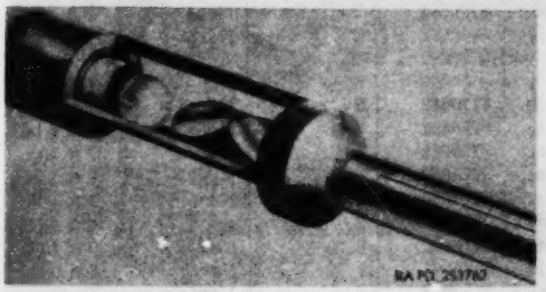


Figure 35. Orienting mirrors for 12-o'clock position with longitudinal line on borescope.

revolve the borescope to get complete coverage (fig. 41). After a complete revolution of the borescope, move it in about ¾ inch and repeat the examination.

c. Interpretation of Borescope Views. The bore of the weapon as seen through a borescope is usually not life size. Due to the various size bores to be inspected and the design of the borescope, the magnification of the viewed area varies. See table V to approximate the magnification to be encountered in each weapon.

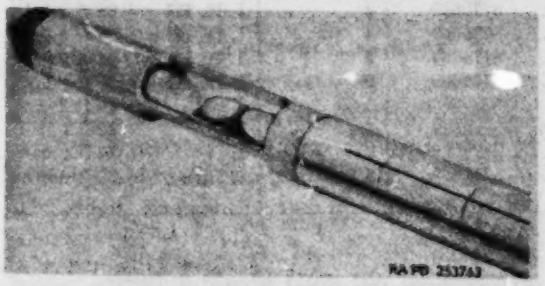


Figure 36. Illuminating head assembly for 20-mm gun installed.

12. Operation of Borescope M2

a. Assembling Operation. The assembly of the borescope requires a minimum of two stands, placed 4½ feet apart, for the basic borescope (assembly without extension tubes). An additional stand is required for each extension tube. The steps necessary to assemble the

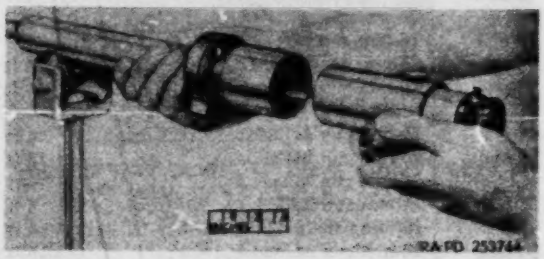


Figure 37. Installing eyepiece assembly on borescope M1.

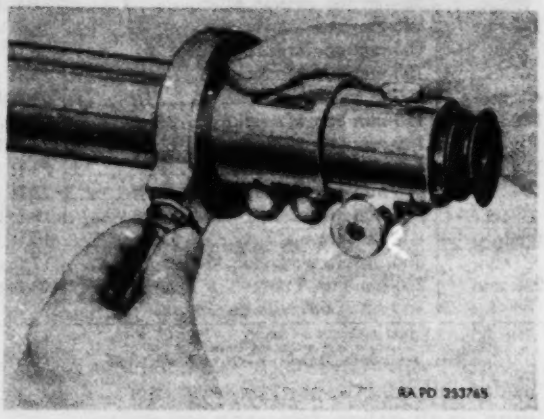


Figure 38. Connecting cord assembly to borescope M1.

Table IV. Assembly of Borescopes

Caliber	Weapon being inspected	Length of gun[1]	Illuminating head assembly required	Supports required	Extension tube required	Length of assembled borescope
		Borescope M1				
20 mm	20-mm gun M3	6 ft 5 in.	8770506	None	None	7 ft 5 in.
	20-mm gun M24A1	6 ft 5 in.	8770506	None	None	7 ft 5 in.
37 mm	37-mm gun M1A2	8 ft 8 in.	8770507	2	None	7 ft 6 in.
	37-mm gun M12 (subcaliber)	2 ft 10 in.	8770507	2	None	7 ft 6 in.
	37-mm gun M13 (subcaliber)	2 ft 10 in.	8770507	2	None	7 ft 6 in.
	37-mm gun M14 (subcaliber)	2 ft 10 in.	8770507	2	None	7 ft 6 in.
	37-mm gun M15 (T34) (subcaliber)	2 ft 10 in.	8770507	2	None	7 ft 6 in.
	37-mm gun M1916 (subcaliber)	2 ft 5 in.	8770507	2	None	7 ft 6 in.
40 mm	40-mm gun M1-series	8 ft 8 in.	8770507	2	None	7 ft 6 in.
		Borescope M2				
57 mm	57-mm rifle T15E16	4 ft 10 in.	8770662	2	None	7 ft 8 in.
	57-mm rifle M18-series	5 ft 1 in.	8770662	2	None	7 ft 8 in.
60 mm	60-mm mortar M2	2 ft 4 in.	8770662	2	None	7 ft 3 in.
	60-mm mortar M19	2 ft 4 in.	8770662	2	None	7 ft 3 in.
	60-mm mortar M31 (subcaliber)	2 ft 4 in.	8770662	2	None	7 ft 3 in.
75 mm	75-mm gun M6	9 ft 8 in.	8770662	3	I	14 ft 3 in.
	75-mm cannon M35	16 ft 3 in.	8770662	3	I, II	20 ft 10 in.
	75-mm howitzer M1A1C	4 ft 11 in.	8770662	2	None	7 ft 8 in.
	75-mm howitzer M3	4 ft 6 in.	8770662	2	None	7 ft 8 in.
	75-mm rifle M20	6 ft 10 in.	8770662	2	None	7 ft 8 in.
	75-mm rifle T21E12	6 ft 10 in.	8770662	2	None	7 ft 8 in.
76 mm	76-mm gun M1-series	13 ft 7 in.	8770662	3	I	14 ft 3 in.
	76-mm gun M32	15 ft 7 in.	8770662	3	I, II	20 ft 10 in.
	76-mm gun M48	16 ft 6 in.	8770662	3	I, II	20 ft 10 in.
81 mm	81-mm mortar M1	3 ft 9 in.	8770862	2	None	7 ft 3 in.
	81-mm mortar M29	4 ft 3 in.	8770862	2	None	7 ft 3 in.
90 mm	90-mm gun M1-series	15 ft 6 in.	8770669	3	I, II	20 ft 10 in.
	90-mm gun M2-series	16 ft 9 in.	8770669	3	I, II	20 ft 10 in.
	90-mm gun M36	14 ft 9 in.	8770669	3	I	15 ft 7 in.
	90-mm gun M41	14 ft 9 in.	8770669	3	I	15 ft 7 in.
	90-mm gun cannon M54	15 ft 6 in.	8770669	3	I	15 ft 7 in.
105 mm	105-mm howitzer M2-series	8 ft 5 in.	8770669	3	I	15 ft 7 in.
	105-mm howitzer M4-series	8 ft 5 in.	8770669	3	I	15 ft 7 in.
	105-mm howitzer cannon M49	8 ft 4 in.	8770669	3	I	15 ft 7 in.
4.2 in.	4.2-in. mortar M30	5 ft 0 in.	8770862	2	None	7 ft 3 in.
120 mm	120-mm gun M1-series	24 ft 3 in.	8770669	4	I, II, III	28 ft 9 in.
	120-mm gun M58	26 ft 5 in.	8770669	4	I, II, III	28 ft 9 in.
155 mm	155-mm gun M2-series	23 ft 1 in.	8770669	5	I, II, III	28 ft 9 in.
	155-mm gun cannon M46	23 ft 4 in.	8770669	5	I, II, III	28 ft 9 in.
	155-mm howitzer M45	12 ft 5 in.	8770669	3	I	15 ft 7 in.
8 in.	8-in. howitzer M2	16 ft 10 in.	8770669	3	I, II	22 ft 2 in.
	8-in. howitzer cannon M47	17 ft 4 in.	8770669	3	I, II	22 ft 2 in.
280 mm	280-mm gun T131	42 ft 8 in.	8770669	5	I, II, III	28 ft 9 in.[2]

[1] From muzzle to rear face of breech ring.
[2] Inspection must be accomplished from both ends of gun.

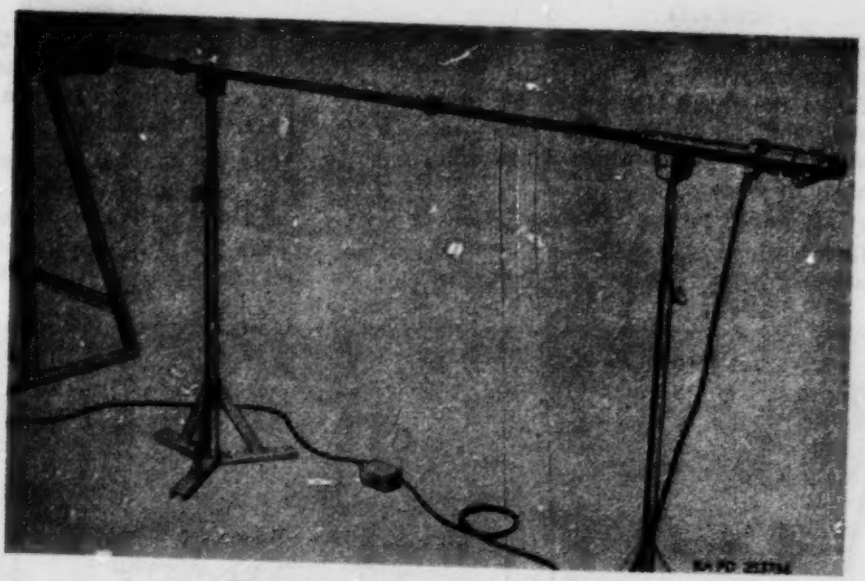


Figure 39. Borescope M1 ready for use.

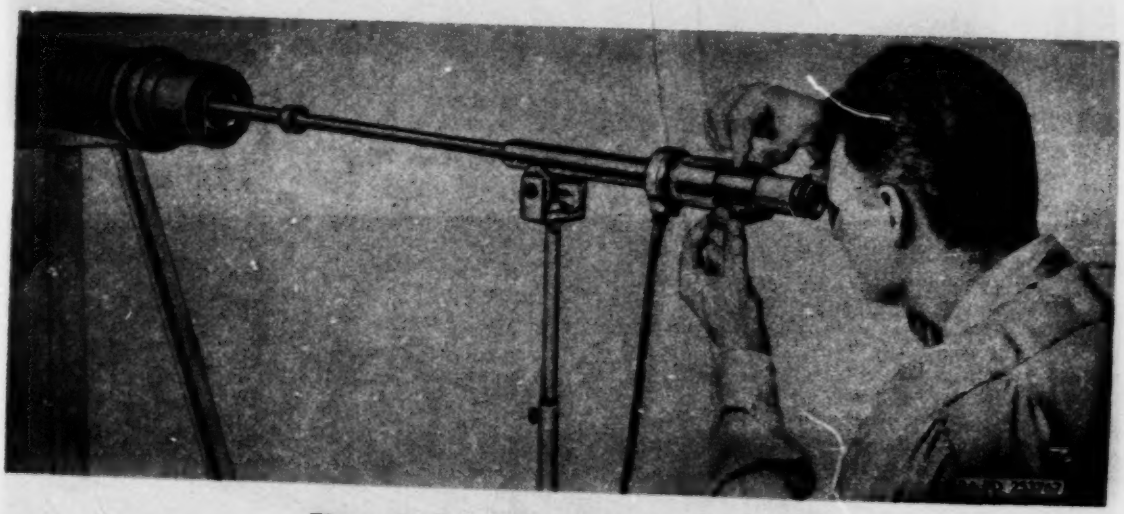


Figure 40. Focusing eyepiece and locking focus.

borescope are contained in (1) through (8) below. See table IV.

(1) Remove the objective tube assembly from the case (fig. 42) and place it on the stands (fig. 43).

(2) Slide two support assemblies over the objective tube (fig. 44). Clamp one about 6 inches from the illuminating head end and the other one about 1 foot from the opposite end.

(3) Consult table IV (par. 11) to determine if extension tubes are required. One support must be assembled to each extension tube at about the midpoint (fig. 45).

Note. Extension tubes may be assembled to the borescope as it enters the weapon and additional length is required (fig. 46).

(4) When assembling extension tubes, aline the engraved center lines, push each bayonet lock on the pins of the

mating part, at the same time firmly turning the tube so that the pins follow the shape of the bayonet lock slot (fig. 47). When the pins are seated, the spring-loaded latch will snap in place.

(5) Consult table IV (par. 11) for correct illuminating head assembly for weapon being inspected. Assemble the illuminating head to the objective tube (fig. 48) in the same manner as the extension tubes are assembled. Refer to (4) above.

(6) Hold the adapter tube assembly with one hand and slide the eyepiece assembly into the adapter tube assembly until the ball detents are heard to seat in the groove (fig. 49).

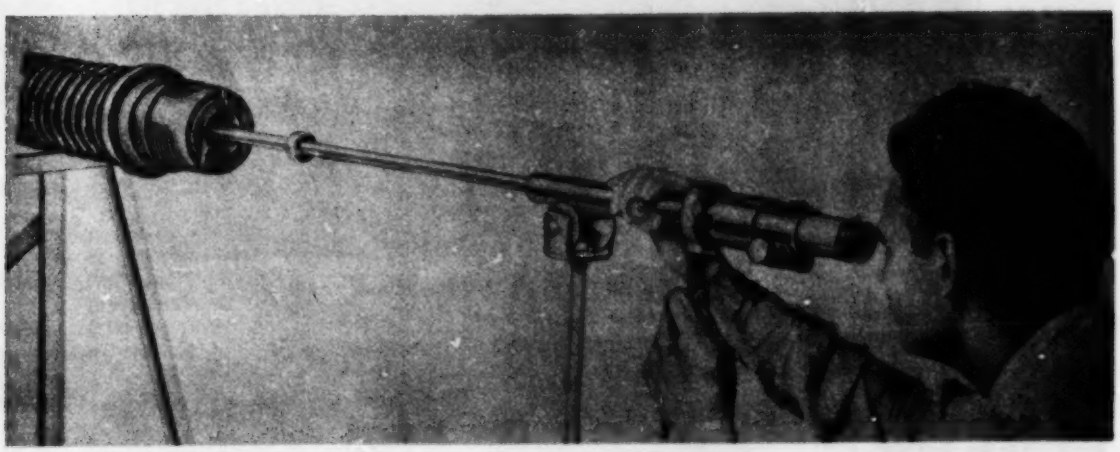


Figure 41. Operation of borescope M1.

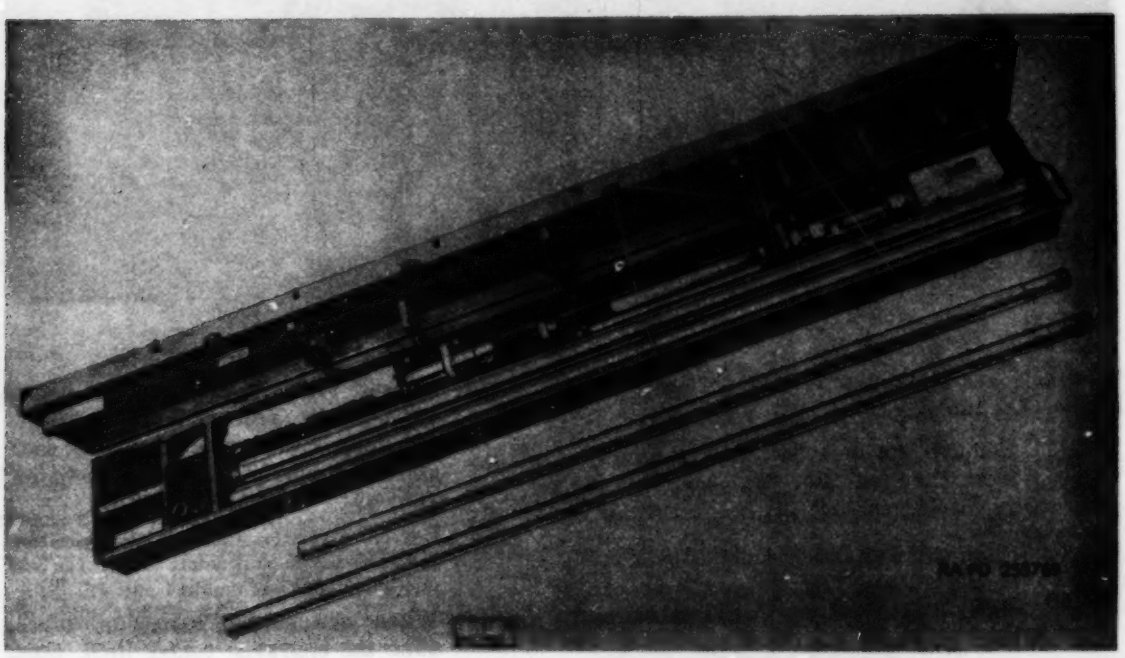


Figure 42. Borescope M2 with objective tube and extension tube out of case.

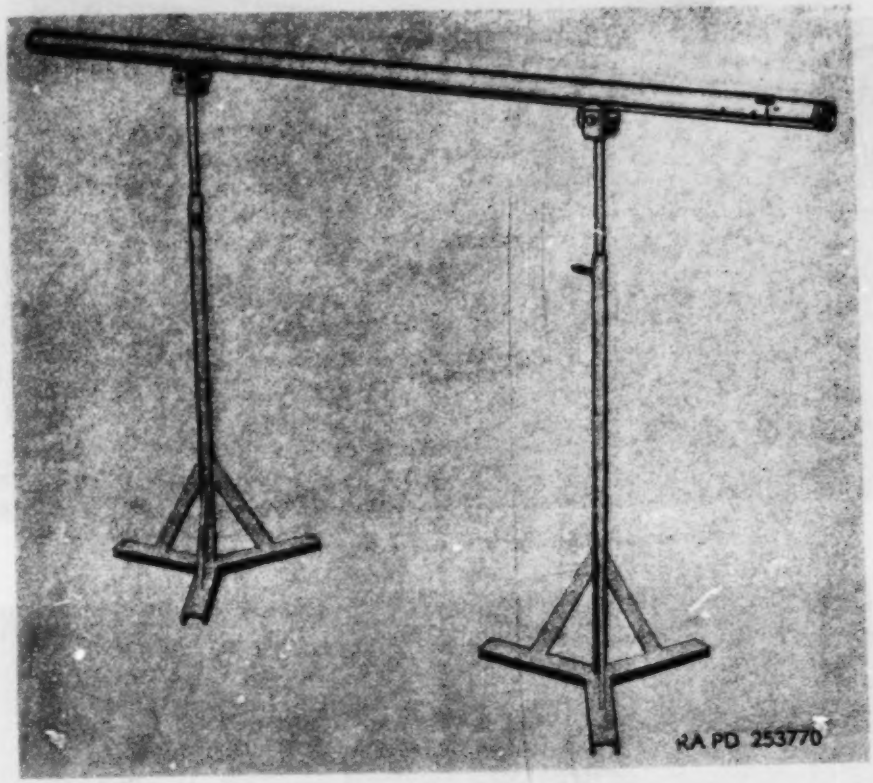


Figure 43. Objective tube on stands.

Table V. Bore Magnification

Cannon bore size	Magnification
Borescope M1 (20 mm–40 mm)	
20 mm	2.7
37 mm	1.8
40 mm	0.8
Borescope M2 (57 mm–280 mm)	
57 mm	2.4
60 mm	2.2
75 mm	2.0
76 mm and 3 inches	2.0
81 mm	1.9
90 mm	1.8
105 mm	1.6
106 mm	1.6
4.2 inches	1.6
110 mm	1.6
120 mm	1.5
155 mm	1.2
175 mm	1.1
8 inches	0.9
280 mm	0.7

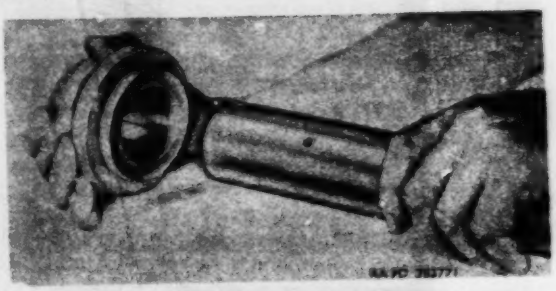


Figure 44. Installing support assembly on tube.

(7) Attach the adapter tube assembly and eyepiece assembly to the objective tube or extension tube in a similar manner to the assembly described in (4) above (fig. 50).

(8) Connect the transformer cord, having the knurled clamping ring, to the collector housing (figs. 51 and 52). Secure the clamping ring finger tight. Do not force or use pliers. Connect the remaining cord in an electrical

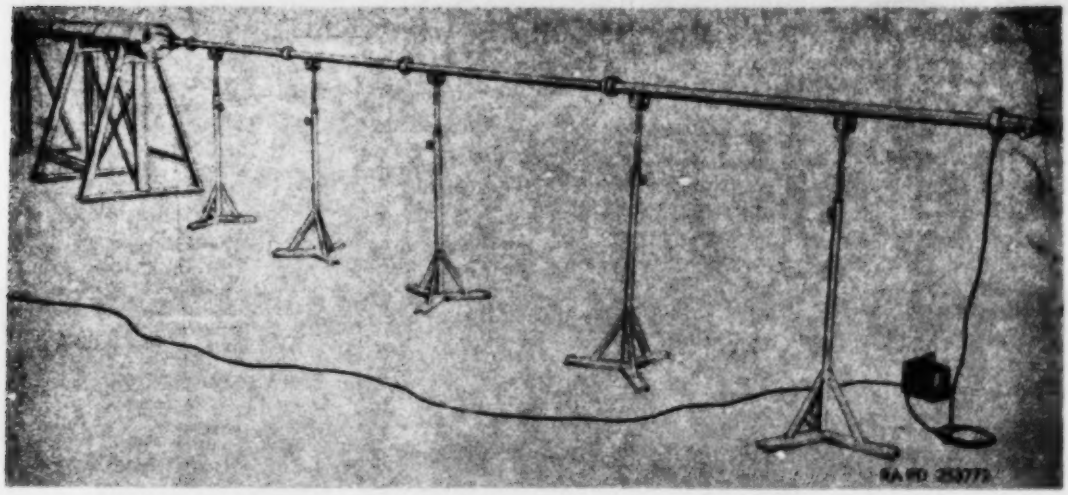


Figure 45. Borescope M2 with extension tubes assembled.

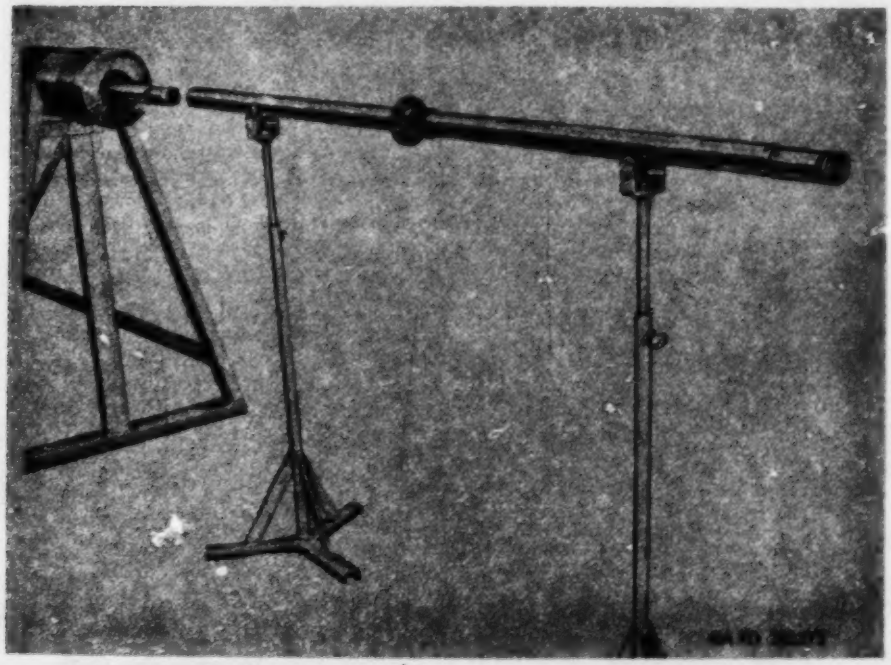


Figure 46. Extension tube installed as borescope M2 enters cannon bore.

outlet supplying 110-volt 60-cycle current. Secure alligator clip to the outlet box or metal conduit.

b. Inserting Borescope in Cannon Tube. Place the required stands in line with the bore to be inspected and at a height to properly center the borescope in the bore. With the borescope carefully resting on the stands, insert it into the bore (fig. 53). Locate the support(s) on the borescope during inspection of the bore, as required. Inspect the bore in a similar manner to that described in paragraph 11*b*.

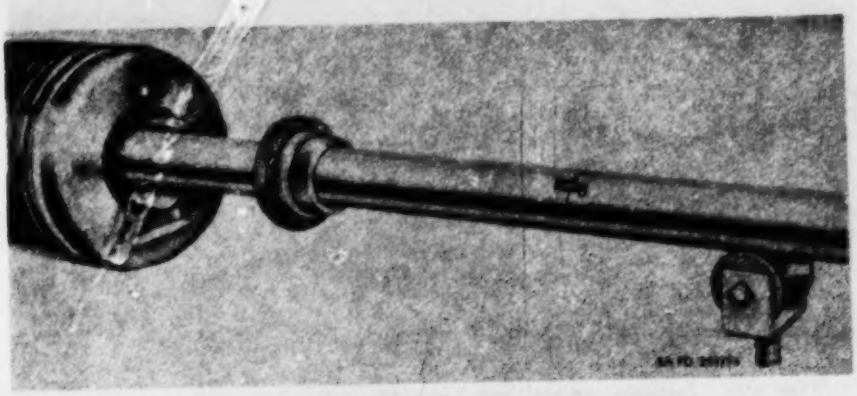


Figure 47. Extension tube connected and locked.

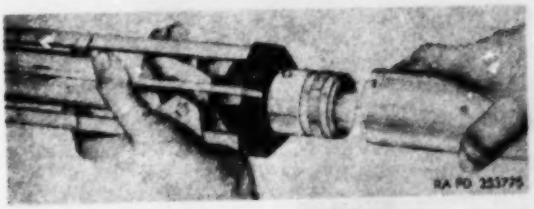


Figure 48. Installing large illuminating head assembly on borescope M2.

c. Interpretation of Borescope Views. A similar condition prevails with the borescope M2 as does with borescope M1. Refer to paragraph 11c and table V for explanation and correction factors.

Note. When using the borescope M2 without the extension tubes, or with two extension tubes, the image appears to be on the opposite side of the tube from its actual position. Allowance must be made for this condition when expressing the position of the image.

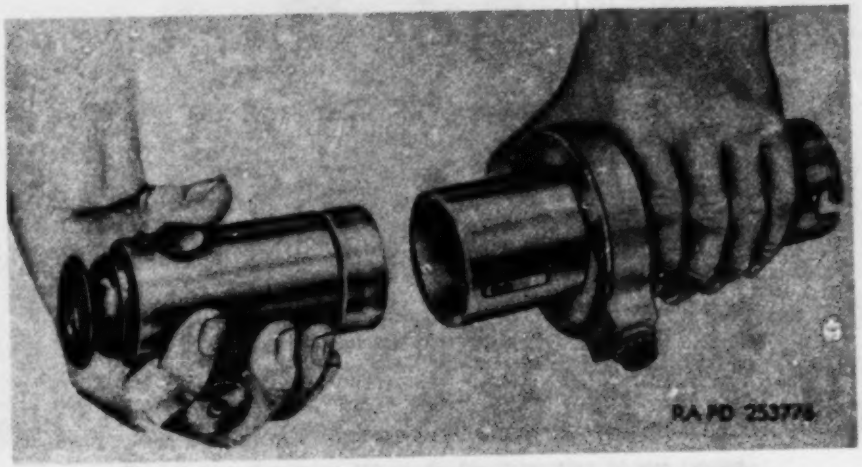


Figure 49. Installing eyepiece assembly on adapter tube assembly.

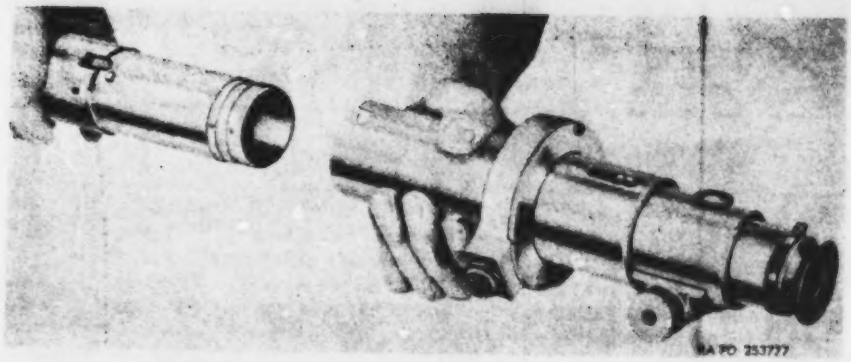


Figure 50. Installing adapter tube assembly and eyepiece assembly on tube.

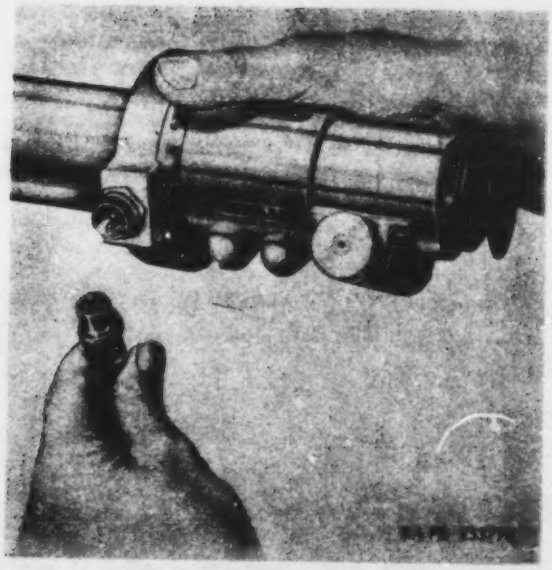


Figure 51. Cord assembly connector before assembly to collector assembly.

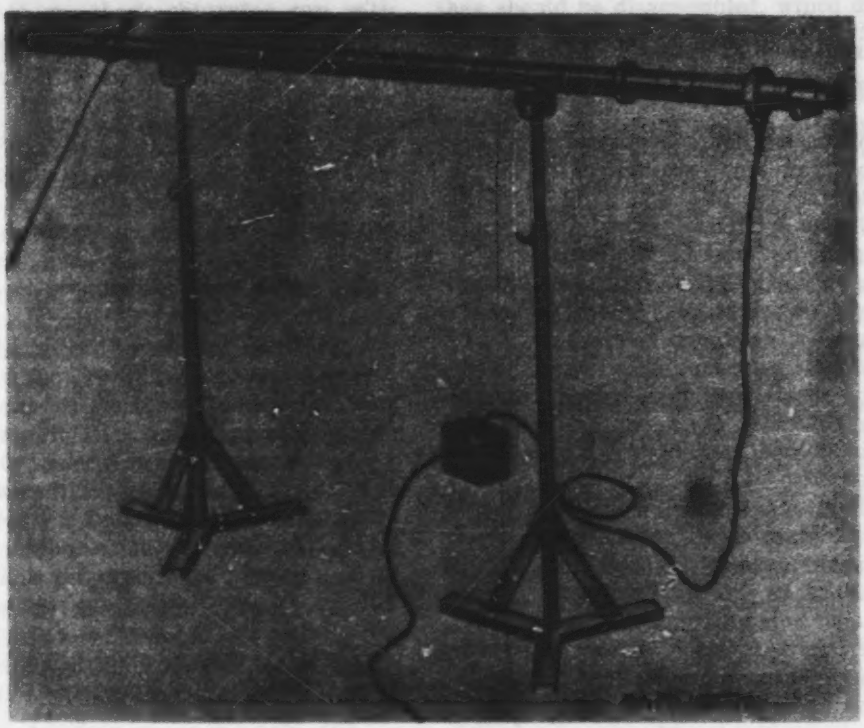


Figure 52. Cord assembly connected to borescope M2 for inspection of mortars.

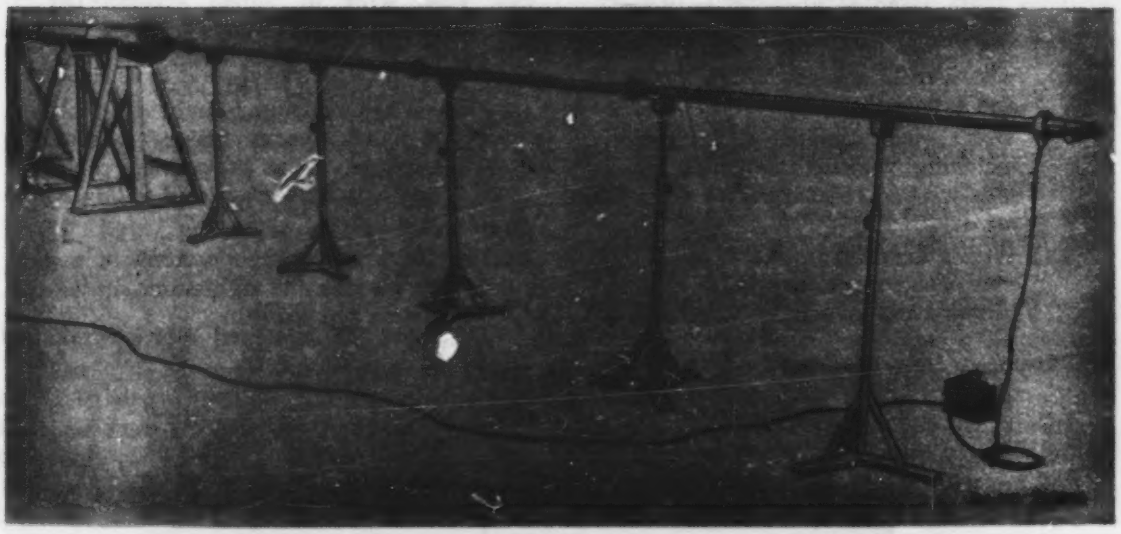


Figure 53. Borescope M2 ready for inspecting 90-mm cannon.

Section III. OPERATION UNDER UNUSUAL CONDITIONS

13. Operation of Pressure Gage M3

a. Assembly (Normal and Elevated Temperature).

(1) Wipe gage components clean and dry internally and externally with a clean cloth.

(2) Grease piston (except anvil end) lightly and seat in gage housing.

(3) Select cylinder, measure its uncompressed height, and record with gage number in weapon record book.

(4) Mount cylinder in cylinder holder and insert into gage housing so that the cylinder is in contact with the piston and concentric with the gage housing.

(5) Mount gage housing in gage bench vise, place a new annealed gas-check washer (greased lightly) on the gage cap, screw the cap down, and tighten.

(6) Remove gage from bench vise and invert on work bench. Insert a new gas-check obturator cup, lightly greased, and press into position with inserter.

(7) Fill gas-check obturator cup with automotive and artillery grease.

(8) Gage is now ready for normal- or excess-temperature firing.

b. Assembly (Subzero Temperatures).

(1) Wipe gage components clean and dry with a clean, dry cloth both internally and externally.

(2) Wash gage components thoroughly, including gas-check washers, in sal soda-wash. Let components drain and air dry.

(3) With a dry, clean piece of cloth, wipe each component carefully both internally and externally to remove sal soda deposit, being careful not to touch components with the fingers.

(4) Assemble piston to gage housing; do not touch piston with fingers.

(5) Lay closing cap, anvil up, on work bench.

(6) Measure uncompressed height of a suitable cylinder and enter height with the gage number in the weapon record book.

(7) Place one end of the cylinder on anvil face of closing cap and locate the cylinder so that it is concentric with the anvil face. Holding the cylinder in place, run a bead of Duco Household Cement around the joint between the anvil face and the cylinder wall. Hold the cylinder in place until the cement has thoroughly dried.

(8) Assemble gas-check washer to gage cap and screw this assembly carefully into the gage housing. Do not tighten cap; leave open about ⅛ inch.

(9) Place gage on perforated rack in a container which can be hermetically sealed. This container should also hold a pan or tray containing an efficient dessicant. The gage should be sealed in the sealed container not less than 24 hours before it is used.

(10) When the gage is to be assembled to a round of ammunition, it should be removed from the sealed container and assembly *completed within a few minutes.*

(11) Mount the gage housing in a gage bench vise and tightening closing cap with a pin wrench.

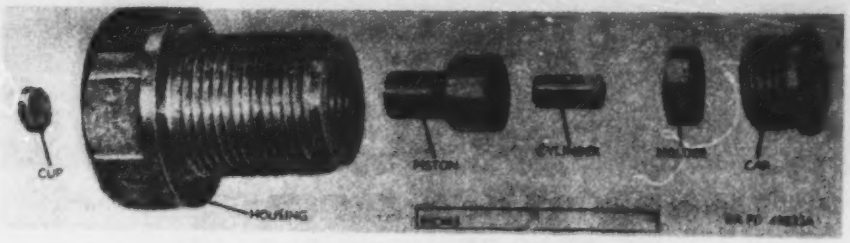


Figure 54. Pressure gage M3—exploded view.

(12) Remove gage from bench vise and insert gas-check obturator cup with inserter.

(13) Fill gas-check obturator cup with automotive artillery grease.

(14) Gage is now ready for assembly to round of ammunition to be conditioned at subzero temperature.

c. Disassembly After Firing.

(1) Match gage number with corresponding number on pressure gage record.

(2) Remove gage cap leaving gas-check washer in place. (If gage cap is tight, mount gage in gage bench vise and loosen with proper pin wrench.)

(3) Push out gas-check obturator cup, piston, cylinder, and cylinder holder, using gas-check inserter handtool.

(4) Remove gas-check washer from gage cap. Then examine gage components for evidence of gas leakage, burns, and gas channeling.

(5) Measure compressed height of cylinder with micrometer gage and enter reading under appropriate gage number in the weapon record book. Note and record skids (cylinders compressed along axis other than cylinder axis), gas leaks, etc., with the compressed height measurement.

(6) Replace piston in gage body and screw on gage cap. Place assembled gage components in a wire basket and wash thoroughly in sal soda solution. Disassemble and wipe gage components with clean, dry cloth.

(7) (For storage only.) Oil all internal and external gage surfaces with a light, protective oil, assemble components and store in a clean, dry place.

14. Operation in Cold Climates

When it is necessary to operate these instruments in cold climates, the following precautions, as described in *a* and *b* below, should be observed.

a. Whenever the instruments are not in use, they should be disassembled, wiped dry, lubricated where required, and stored in their cases or containers.

b. Do not allow snow or ice to collect on the connecting or moving parts. Remove snow or ice and wipe dry all connecting and moving parts before attempting to assemble or move parts. Remove rust, if present, and lubricate where required (pars. 7 and 8).

15. Operations in Hot Climates

Where the temperature and humidity are high, the instruments should be inspected daily and cleaned thoroughly. They should be free from mud, fungus, or other foreign matter and should be lubricated where required. Whenever the instruments are not in use, they should be disassembled and stored in their cases or containers.

16. Operation in Salty Atmosphere

The precautions to be observed for operation in salty atmosphere are similar to those for hot climates. However, extra care should be exercised since parts are more apt to corrode in salty atmospheres.

17. Operation in Sandy or Dusty Conditions

Operation in sandy or dusty areas requires constant inspection to prevent excessive wear of the instruments. The following precautions should be observed:

a. Avoid excessive lubrication as it tends to hold dust and may cause rapid wear and seizing of parts.

b. Inspect and clean all connecting and moving parts more frequently when operating in sandy areas.

c. Clean the bores of the weapons to be inspected.

d. Keep the borescope covered whenever conditions permit.

e. Disassemble and store the instruments in their cases or containers when not in use.

CHAPTER 3

MAINTENANCE INSTRUCTIONS FOR USING PERSONNEL

Section I. SPARE PARTS, TOOLS, AND EQUIPMENT FOR OPERATION AND MAINTENANCE

18. General

Spare parts, tools, and equipment are issued to the using personnel for operating and maintaining the pullover gages, borescopes, and pressure gage M3. Tools and equipment should not be used for purposes other than prescribed and when not in use, should be properly stored.

19. Spare Parts

No spare parts are supplied to the using personnel for replacement on the pullover gages or borescopes. Spare parts supplied for the pressure gage M3 are listed in Department of the Army Supply Manual ORD 6 SNL J–33 as components of the gage.

20. Common Tools and Equipment

Common tools and equipment are listed in ORD 6 SNL J–33 and are authorized for issue by Tables of Allowances or Tables of Organization and Equipment.

21. Special Tools and Equipment

Certain tools and equipment specially designed for operation and general use with the materiel are listed in table VI for information only. This list is not to be used for requisitioning replacements.

Table VI. Special Tools and Equipment

	Identifying number	References		Use
		Fig.	Par.	
Borescope M1:				
SUPPORT, gun 37-mm tube	8770657	6	5a(5)	Support Borescope M1 in weapon bore.
SUPPORT, gun 40-mm tube	8770601	6	5a(5)	
Borescope M2:				
ADAPTER, ASSY	8770908	24	5b(7)	Hold supports on borescope.
CENTERING RING ASSEMBLY	8770773	25	5b(7)	Hold reflectors on illuminating head and borescope.
REFLECTOR, FRONT plywood 10¾ in. dia, ¼ in. thk.	8770804	25	5b(7)	Reflect illuminating headlight on 280-mm weapon.
REFLECTOR, REAR: plywood, 10¾ in. dia, ¼ in. thk.	8770805	25	5b(7)	
SUPPORT, SLEEVE, SPLIT, 57-mm	8770794	25	5b(7)	
SUPPORT, SLEEVE, SPLIT, 60-mm	8770795	25	5b(7)	
SUPPORT, HINGED, 75-mm	8770827	25	5b(7)	
SUPPORT, HINGED, 76-mm and 3-inch	8770828	25	5b(7)	
SUPPORT, HINGED, 81-mm	8770829	25	5b(7)	
SUPPORT: fiber, 2.568 in. id, 3.533 in. od, ½ in. thk (90-mm).	8770878	24	5b(7)	Support borescope in weapon bore.
SUPPORT: fiber, 2.568 in. id, 4.124 in. od, ½ in. thk (105-mm).	8770879	24	5b(7)	

Table VI. Special Tools and Equipment—Continued

	Identifying number	References		Use
		Fig.	Par.	
SUPPORT: fiber, 2.568 in. id, 4.190 in. od, ½ in. thk (4.2 in.).	8770880	24	5b(7)	
SUPPORT: fiber, 2.568 in. id, 4.690 in. od, ½ in. thk (120-mm).	8770881	24	5b(7)	
SUPPORT: fiber, 2.568 in. id, 6.090 in. od, ½ in. thk (155-mm).	8770882	24	5b(7)	
SUPPORT: fiber, 2.568 in. id, 6.880 in. od, ½ in. thk (175-mm).	8770883	24	5b(7)	
SUPPORT: fiber, 2.568 in. id, 7.990 in. od, ½ in. thk (8 in.).	8770884	24	5b(7)	Support borescope in weapon bore.
SUPPORT: fiber, 2.568 in. id, 9.440 in. od, ½ in. thk (240-mm).	8770885	24	5b(7)	
SUPPORT: fiber, 2.568 in. id, 11.015 in. od, ½ in. thk (280-mm).	8770886	24	5b(7)	

Section II. PREVENTIVE-MAINTENANCE SERVICES

22. General

Preventive-maintenance services are a function of the using personnel and are provided as a means to conserve the materiel. These services are described in paragraphs 23 and 24 and are primarily concerned with the inspection, cleaning, and lubricating operations necessary for maintaining the instruments in a usable condition. The intervals of preventive-maintenance service for the instruments are based on the operating conditions (pars. 13–17).

23. Inspection

a. Inspect the instruments for general condition, loose or broken components, rust, dents, gouges, or other defects which may impair their use.

b. Operate the instruments to insure that all components are correct.

c. Consult paragraphs 7 and 8 for additional pertinent instructions.

24. Cleaning and Lubricating

a. Particular care should be taken to keep all bearing and sliding surfaces free from rust, dirt, grit, gummed oil, or other foreign matter.

b. Remove traces of corrosion with crocus cloth. Do not use coarse abrasive materials which may alter the shape or dimensions of the part.

c. Remove oil with appropriate solvent.

d. Remove dust and dirt with dry cloth.

e. Clean exposed optical surfaces only with required brush and lens tissue (fig. 55).

f. Use proper lubricant prescribed and lubricate where required (par. 7*b* (2)).

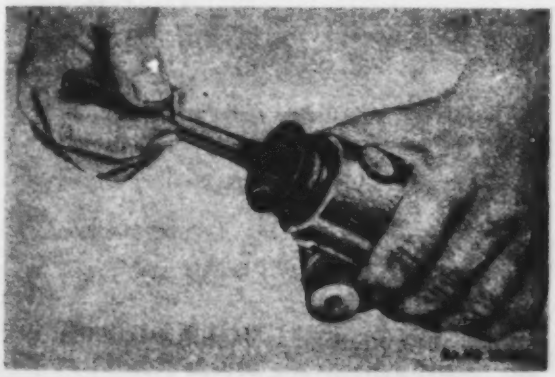


Figure 55. Eyepiece lens cleaned with brush.

Section III. TROUBLESHOOTING

25. General

It is the purpose of troubleshooting to locate and correct any malfunctions which may temporarily prevent the instrument from operating properly. This section will contain the troubleshooting instructions for the borescopes only, as the pullover gages require only those instructions listed in paragraph 8 for maintaining them in a usable condition. The troubleshooting instructions for the borescopes will be confined to the checking of the electrical circuit. At no time will the borescope subassemblies be disassembled by the using organization.

26. Failure of Illuminating Head Lamp To Light

a. Failure of illuminating head lamp to light may be caused by defective transformer wiring and cord assemblies, broken or loose electrical connections, burned out lamps, or blown fuse in power supply assembly.

b. Make sure all components of the borescope are connected properly. Check cord assembly from transformer to collector housing. Tighten loose connections.

c. Remove lamp from illuminating head and replace with spare lamp supplied with borescope.

d. If lamp fails to light, check transformer for overheating. Check cord assemblies for broken, exposed, or frayed leads. Report any such conditions to maintenance personnel.

e. If none of the above steps correct the malfunction, disconnect the borescope from the power source. Check for loose or broken electrical connections. Report any such conditions to maintenance personnel and correct as quickly as possible.

27. Distorted Image

a. A distorted image results from damage to a lens by heat, moisture, or cracks.

b. Damaged lenses will be replaced by depot maintenance personnel only.

CHAPTER 4

FIELD MAINTENANCE INSTRUCTIONS

Section I. GENERAL

28. Scope

The instructions in this chapter are for the information and guidance of personnel responsible for field maintenance. These instructions contain information on maintenance which is beyond the scope of the spare parts, tools, equipment, or supplies normally available to using organizations. This chapter does not contain information for the using organization since such information is available in the other chapters of this manual.

29. Procedure

This chapter contains procedures for inspection, disassembly, repair, assembly, and troubleshooting of the pullover gages and illuminating heads.

Section II. PARTS, SPECIAL TOOLS, AND EQUIPMENT FOR FIELD MAINTENANCE

30. General

Tools, equipment, and maintenance parts over and above those available to the using organization are supplied to ordnance field maintenance units for repairing the materiel.

31. Maintenance Parts

Maintenance parts are listed in Department of the Army Supply Manual ORD 8 SNL J–717, Sections 1, 2, and 3 which is the authority for requisitioning replacements.

32. Special Tools and Equipment

No special tools or equipment for performing the operations in this chapter are required.

Section III. PULLOVER GAGES

33. General

a. Pullover gage components are illustrated in figures 56 and 57.

b. Refer to paragraphs 25 and 26 above for troubleshooting.

34. Disassembly

a. Spring. Remove the adjusting nut and withdraw spring and adjusting screw.

b. Body and Slide. Remove the slide from the top of the body. The knurled slide pin is drifted from the slide, if replacement is required. Remove two vernier screws and withdraw vernier.

c. Hinge. Remove cotter pin and headed pin from each hinge and remove two hinges.

d. Stop. Drift out the two stops, if replacement is required.

35. Inspection and Repair

a. Inspect the spring for set and cracks. Replace, if damaged.

b. Replace the adjusting nut and adjusting screw, if threads are worn or stripped.

c. Remove nicks or burs from the body or slide with crocus cloth.

d. Replace the slide, if dented or worn or scale is illegible.

e. Replace the vernier, if scale is illegible.

36. Assembly

a. Stop. Replace two stops using a hydraulic press.

b. Hinge. Aline holes in hinge with hole in stop and insert headed pin through holes. Secure headed pin with $\frac{1}{16}$ x $\frac{1}{2}$ cotter pin.

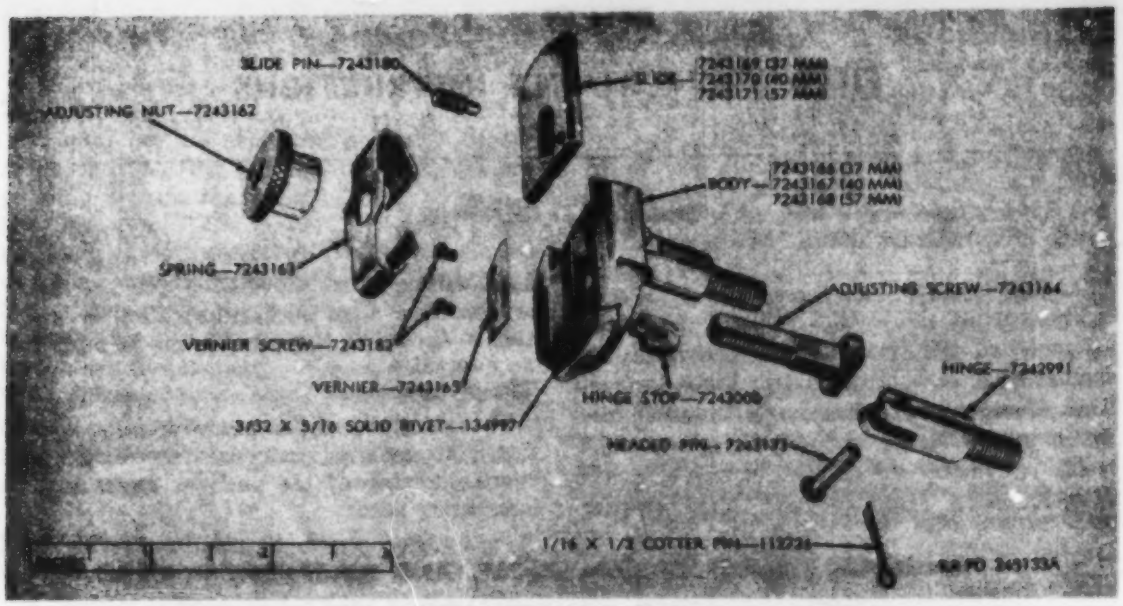


Figure 56. Pullover gage (37-mm through 57-mm weapon)—exploded view.

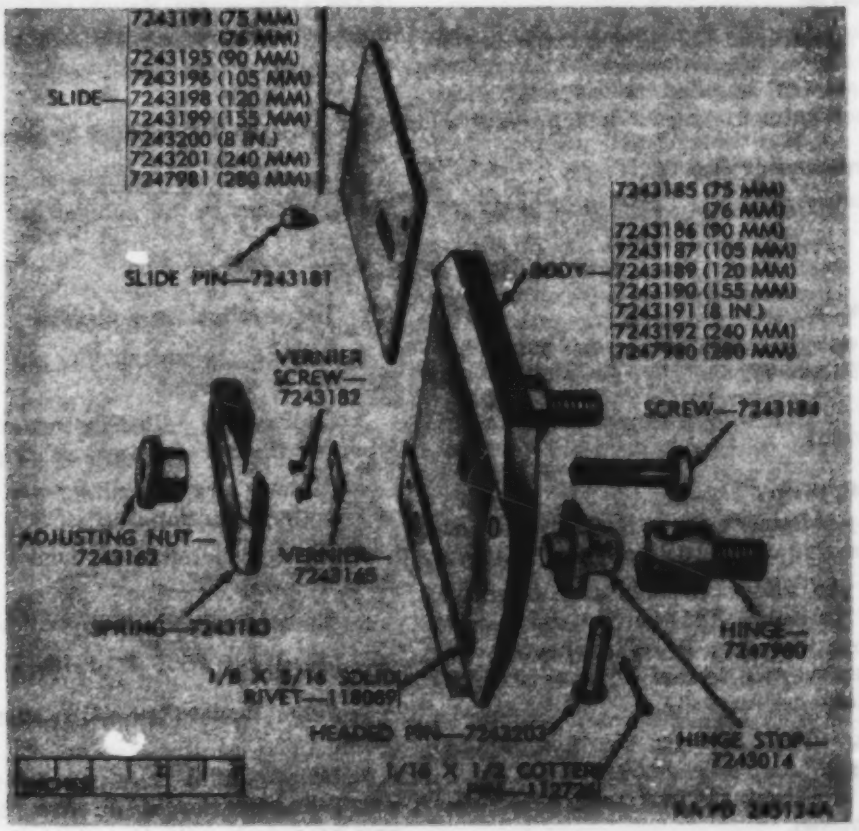


Figure 57. Pullover gage (75-mm through 280-mm weapon)—exploded view.

c. Body and Slide. Replace the knurled slide pin in slide with a hydraulic press. Push the slide into the body and insert the adjusting screw through openings in body and slide. Position vernier on body and secure with two vernier screws.

d. Spring. Install spring over threaded end of adjusting screw and secure with adjusting nut.

Section IV. FINAL INSPECTION OF PULLOVER GAGES

37. General

Final inspection is performed after all repair has been completed and the pullover gage has been assembled to insure that the materiel is serviceable. It includes a visual inspection for proper assembly of the materiel and a functional check to make sure that the gage is in proper condition.

38. Visual Inspection and Functional Check

a. Inspect vernier scale and slide scale for legibility.

b. Move the slide in the body; the movement must be smooth.

c. Aline the zero on the slide with the zero on the vernier and tighten the adjusting nut. Check the gage with a vernier caliper; the caliper reading should be the same as that engraved on the body of the gage. If the reading is different, replace the vernier screws or vernier and screws and repeat the check. If engraved reading is not obtained, replace the gage.

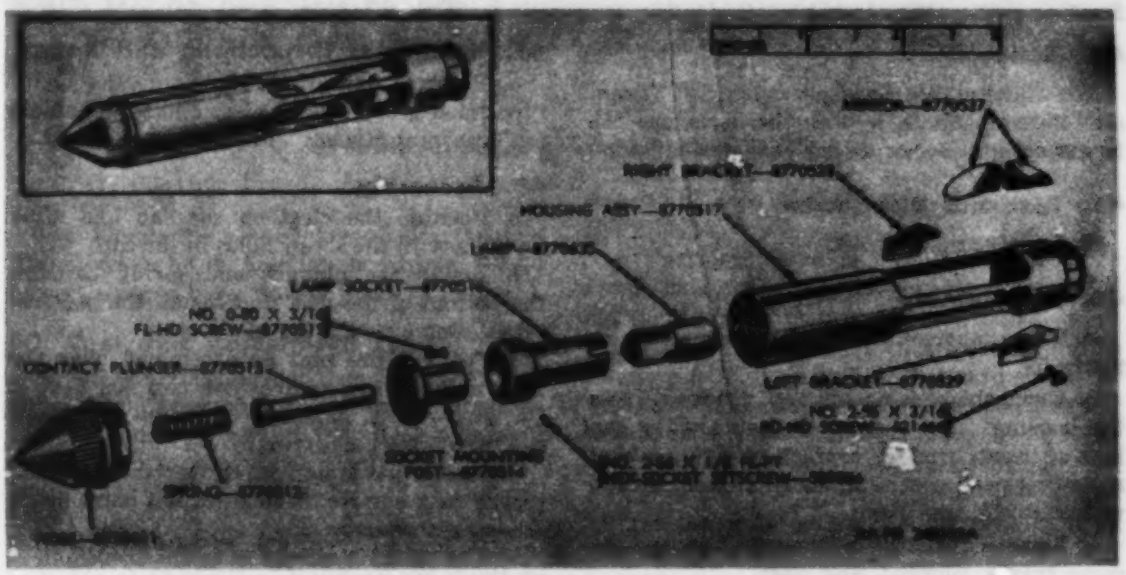


Figure 58. Illuminating head assembly for 20-mm gun—exploded view.

Section V. ILLUMINATING HEAD ASSEMBLY FOR 20-MM GUNS

39. General

The illuminating head assembly for 20-mm guns is used on the borescope M1 to inspect gun bores during bore evaluation.

40. Test and Adjustment

Install head on borescope M1 (par. 5*a*(3)). Connect lighting transformer to power source and the borescope and check operation of head lamp. If lamp does not light, replace lamp.

41. Disassembly

a. The components of this head are shown in figure 58.

b. Unscrew the nose from the housing. Attached to the nose are the lamp, lamp socket, socket mounting post, contact plunger, and spring. Twist the lamp and pull from the socket. Remove setscrew and slip the socket off the post. Unscrew the two screws that secure the post to the nose and remove post, plunger, and spring.

c. Unscrew four screws, that attach mirrors to brackets and that clamp the brackets to the web of the housing assembly, and remove two mirrors and two brackets.

42. In-Process Inspections and Repair

a. General. Acceptance of the assembled head depends largely upon the care exercised during inprocess inspections and repair.

b. Mirror. Inspect mirror for cracks or scratches. Replace mirror, if damaged.

c. Spring. Inspect spring for set or broken coils. Replace spring, if damaged.

43. Assembly

a. Install the spring and contact plunger in the nose.

b. Install the socket mounting post over the spring and plunger into the nose and secure with two No. 0–80 x 3/16 flat-head screws.

c. Install the lamp socket over the post and secure with one No. 2–56 x 1/8 flat-point hexagon-socket setscrew.

d. Install the lamp in the lamp socket and secure.

e. Install two mirrors on left and right brackets and secure with two No. 2–56 x 3/16 round-head screws. Install brackets on web of housing and secure with two No. 2–56 x 3/16 round-head screws.

f. Insert the nose as assembled into threaded opening of housing and tighten.

Section VI. ILLUMINATING HEAD ASSEMBLY FOR 37-MM AND 40-MM GUNS

44. General

The illuminating head assembly for 37-mm and 40-mm guns is used on the borescope M1 to inspect gun bores during bore evaluation.

45. Test and Adjustment

Refer to paragraph 40.

46. Disassembly

a. The components of the head are shown in figure 59.

b. Twist the housing cap and remove it from the housing. Attached to the cap are the cap locking cleat, spring, contact plunger, socket mounting post, post retainer ring, lamp socket, socket shield, and lamp.

c. Remove two screws from the cap and remove spring, plunger, and cleat.

d. Twist the lamp in the socket and remove lamp and socket shield.

e. Remove setscrew from lamp socket and withdraw socket mounting post and post retainer ring.

f. Remove four screws, two that mount the mirrors to the brackets and two that clamp the brackets to the housing, and remove two mirrors and two brackets.

47. In-Process Inspections and Repair

a. Refer to paragraph 42.

b. Inspect cap locking cleat and socket shield for cracks and wear. Replace, if damaged.

48. Assembly

a. Position the cleat on the cap and aline its holes with the screw holes in the cap.

b. Install the plunger and spring through the bottom of the post and install the post retainer ring over the top of the post.

c. Position the post as assembled over the cleat and cap and secure with two No. 4–40 x 1/2 cross-recess fillister-head screws through cap, cleat, post, and ring.

d. Install the lamp socket over the post and secure with one No. 2–56 x 3/16 flat-point hexagon-socket setscrew.

e. The shield is a force fit in the socket.

f. Install the lamp in the socket and turn it in the groove until secure.

g. Install the cap as assembled in the large opening of the housing assembly and turn until secure.

h. Install the two mirrors on the two brackets and secure with two No. 4–40 x 3/16 cross-recess pan-head screws. Secure the brackets on the web of the housing with two No. 4–40 x 3/16 cross-recess pan-head screws.

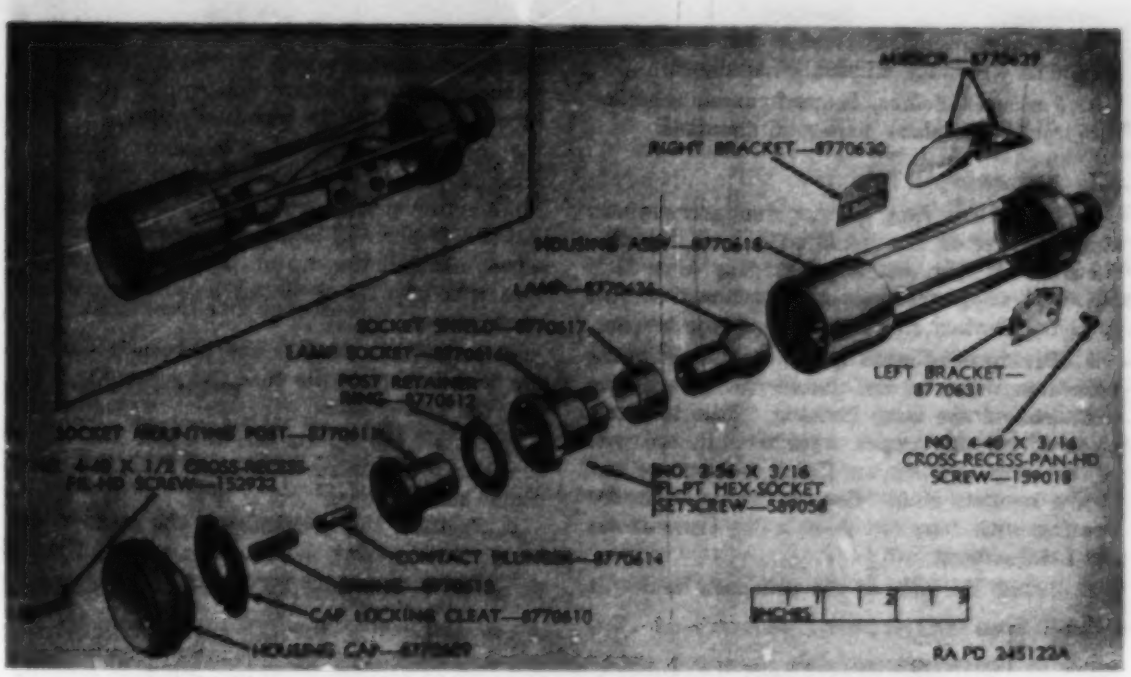


Figure 59. Illuminating head assembly for 37-mm and 40-mm guns—exploded view.

Section VII. SMALL ILLUMINATING HEAD ASSEMBLY FOR 57-MM THROUGH 90-MM WEAPONS

49. General

The illuminating head for 57-mm through 90-mm weapons is used on borescope M2 to inspect weapon bores during bore evaluation.

50. Test and Adjustment

Install illuminating head on borescope M2. Connect power supply assembly to borescope and the source of power and check operation of head lamp. If lamp does not light, replace lamp.

51. Disassembly

a. The components of this head are shown in figure 60.

b. Unscrew the showcase lamp from its holder.

c. Remove two screws that fasten the cap to the lamp housing and withdraw the cap a few inches to remove the copper wire. Remove screw and lockwasher connecting wire to cap.

d. Back off two screws in base of porcelain holder and remove short wire and disconnect one end of long wire. Remove the holder from the housing.

e. Unsolder the other end of the long wire from the contact ring on the opposite end of the housing and remove the long wire.

f. Remove four screws that secure the tube in one end of the lamp housing and remove the tube, being careful not to lose the latch spring and latch.

g. Remove the eight screws that attach the lock ring and the support ring to the tube and remove the rings and also the contact ring from the tube.

h. Remove two screws that clamp the right and left brackets to the housing web and remove the brackets and mirror. Remove four screws and separate the brackets from the mirror.

52. In-Process Inspections and Repair

a. General. Acceptance of the assembled head depends largely upon the care exercised during inprocess inspections and repair.

b. Mirror. Inspect mirror for cracks or scratches. Replace mirror, if damaged.

c. Porcelain Holder. Inspect porcelain holder for cracks. Replace holder, if damaged.

53. Assembly

a. Install lock ring, contact ring, and support ring in order on the insulated end of the tube. Secure lock ring and support ring with four No. 0–80 x 3/16 cross-recess fillister-head screws in each. Contact ring is held by spring tension.

b. Position the latch spring and latch in the groove in the tube and install the tube in the wide end of the lamp housing. Run the long piece of No. 20 copper wire through the web of the lamp housing and lightly solder one end to the contact ring. Secure the tube in the housing with four No. 4–40 x 3/16 cross-recess flat-head screws.

c. Install the base of the porcelain holder in the narrow end of the lamp housing and secure the free end of the No. 20 copper wire to its terminal screw. Secure one end of the short (ground) wire to its terminal screw.

d. Install the free end of the short (ground) wire on the housing cap and secure with one No. 4 screw size internal-teeth lockwasher and one No. 4–40 x 3/16 brass cross-recess pan-head screw. Install the cap on the housing and secure with two No. 4–40 x 3/16 cross-recess flat-head screws.

e. Install the washer and porcelain part of the lamp holder on the base and screw the lamp into the holder base.

f. Install the mirror on the left and right brackets and secure with four No. 2–56 x 1/8 round-head screws.

g. Position the brackets on the web of the lamp housing and secure with two No. 4–40 x 3/16 brass cross-recess pan-head screws.

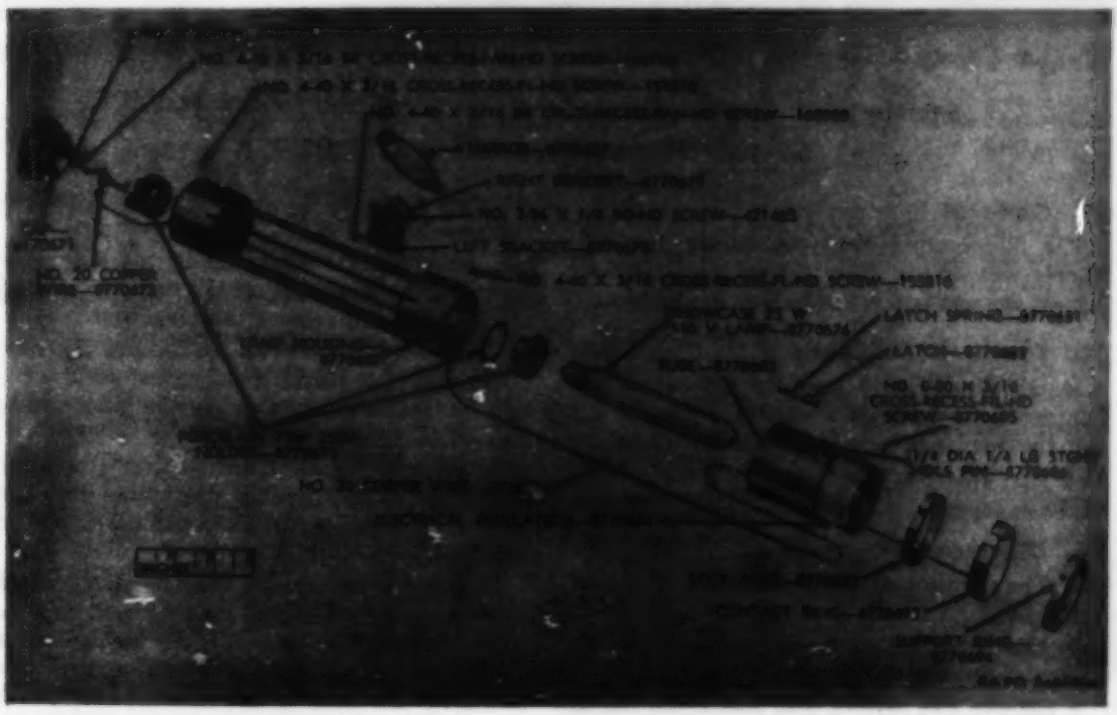


Figure 60. Small illuminating head assembly for 57-mm through 90-mm weapons—exploded view.

Section VIII. LARGE ILLUMINATING HEAD ASSEMBLY FOR 105-MM THROUGH 280-MM WEAPONS

54. General

The large illuminating head for 105-mm through 280-mm weapons is used on the borescope M2 to inspect gun bores during bore evaluation.

55. Test and Adjustment

Refer to paragraph 50.

56. Disassembly

a. The components of the large illuminating head assembly are shown in figures 61 and 62.

b. Remove setscrew from each lamp support and remove three supports.

c. Unscrew the lamp from its socket.

d. Remove the socket-head screw and flat washer that secures the ground wire to the socket end.

e. Remove the cross-recess round-head screw from inside the porcelain socket and remove the socket and washer from the socket end. Remove the two wires from the base of the porcelain socket.

f. Remove four screws that secure the tube to the contact end and remove the tube. Remove the latch spring and latch from the tube groove.

g. Unsolder the wire from the contact ring and remove ring and wire. Remove four cross-recess flat-head screws from the lock ring and from the support ring and remove the rings from the tube.

h. Remove two cup-point hex-socket setscrews from cleat and remove cleat with mirror mounting bracket and mirror attached. Remove four screws from mounting bracket and remove mirror. Unscrew hexagon nut from cleat and remove washer, bolt, and mirror mounting bracket.

i. Remove six socket-head screws from contact end and from socket end and remove ends.

57. In-Process Inspections and Repair

a. General. Refer to paragraph 52*a*.

b. Mirror. Refer to paragraph 52*b*.

c. Socket. Inspect socket for cracks. Replace socket, if damaged.

d. Ends. Inspect socket end and contact end for cracks. Replace ends, if damaged.

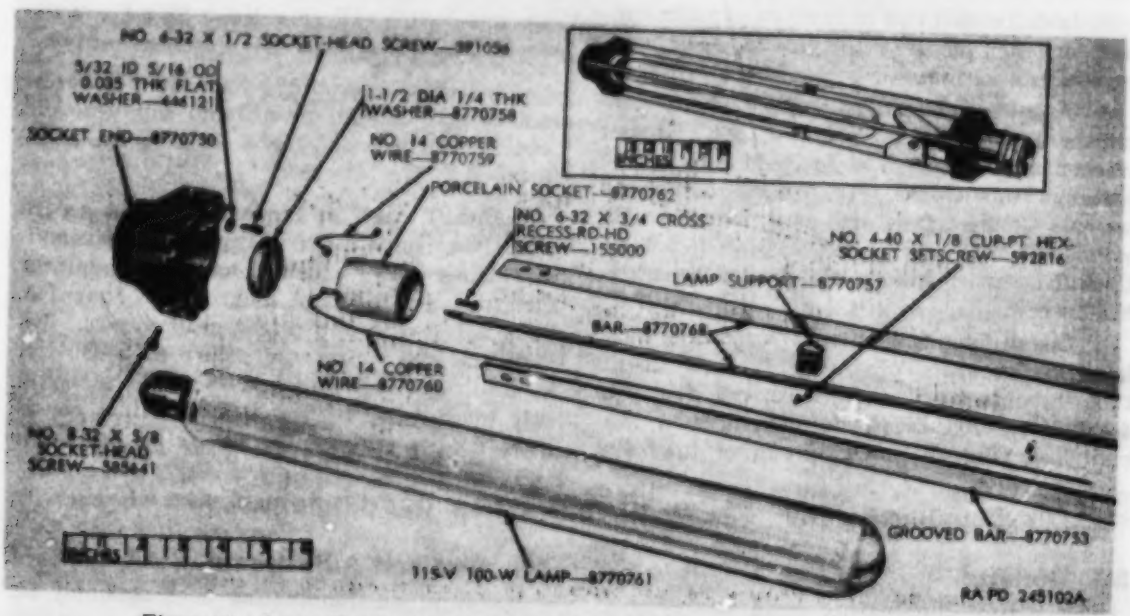

NO. 6-32 X 1/2 SOCKET-HEAD SCREW—391056
5/32 ID 5/16 OD 0.035 THK FLAT WASHER—446121
1-1/2 DIA 1/4 THK WASHER—8770758
SOCKET END—8770730
NO. 14 COPPER WIRE—8770759
PORCELAIN SOCKET—8770762
NO. 6-32 X 3/4 CROSS RECESS-RD-HD SCREW—155000
NO. 4-40 X 1/8 CUP-PT HEX SOCKET SETSCREW—592816
LAMP SUPPORT—8770757
BAR—8770768
NO. 14 COPPER WIRE—8770760
NO. 8-32 X 5/8 SOCKET-HEAD SCREW—585641
GROOVED BAR—8770753
115-V 100-W LAMP—8770761
RA PD 245102A

Figure 61. Large illuminating head assembly for 105-mm through 280-mm weapons—partial exploded view.

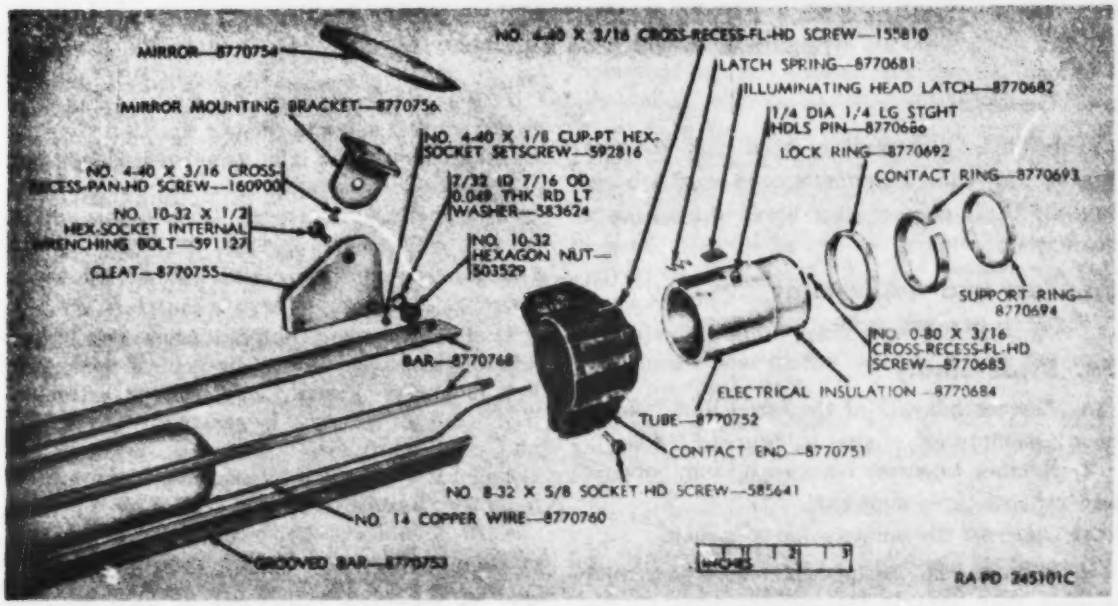


Figure 62. Large illuminating head assembly for 105-mm through 280-mm weapons—partial exploded view.

58. Assembly

a. Install contact end in position and secure with six No. 8–32 x 5/8 socket-head screws.

b. Install socket end in position opposite contact end and secure with six No. 8–32 x 5/8 socket-head screws.

c. Install ends of No. 14 copper wires to terminals in base of porcelain socket. Install washer and socket in socket end and secure with one No. 6–32 x 3/4 cross-recess round-head screw. Connect free end of ground wire to socket end with one 5/32 i.d. x 5/16 o.d. x 0.065 thick flat washer and one No. 6–32 x 1/2 socket-head screw.

d. Install latch spring and illuminating head latch in groove in tube (fig. 62) and install tube in contact end and secure with four No. 4–40 x 3/16 cross-recess flat-head screws. Install lock ring on insulated end of tube and secure with four No. 0–80 x 3/16 cross-recess flat-head screws. Install contact ring next to lock ring and solder free end of No. 14 copper wire to it. Install support ring next to contact ring and secure with four No. 0–80 x 3/16 cross-recess flat-head screws.

e. Install a 115-volt 100-watt lamp in porcelain socket. Install three lamp supports and secure each with one No. 4–40 x 1/8 cup-point hexagon-socket setscrew.

f. Install cleat on grooved bar and secure with two No. 4–40 x 1/8 cup-point hexagon-socket setscrew. Install mirror on mirror mounting bracket and secure with four No. 4–40 x 3/16 cross-recess pan-head screws. Install bracket in cleat and secure with one No. 10–32 x 1/2 hexagon-socket internal wrenching bolt, one 7/32 i.d. x 7/16 o.d. x 0.049 thick round light washer and one No. 10–32 hexagon nut.

Section IX. PRISM ILLUMINATING HEAD ASSEMBLY

59. General

The prism illuminating head assembly is used with borescope M2 when inspecting mortar tube for bore evaluation.

60. Test and Adjustment

Install prism illuminating head assembly on borescope M2. Connect power supply assembly to borescope and to the source of supply and

check operation of lamps. If lamp does not light, replace defective lamp.

61. Disassembly

a. The components of the prism illuminating head are shown in figure 63.

b. Remove screw that locks prism cap to prism sleeve and remove cap.

c. Remove two lamps from prism mount.

d. Unsolder No. 20 copper wire from contact ring and remove ring.

e. Remove six screws that secure tube to sleeve and remove illuminating head latch and latch spring. With one hand holding the sleeve, carefully pull the prism tube and prism mount from the sleeve. Remove two screws that secure the mount to the tube and remove the mount.

f. To replace the prism, remove two screws from each prism clamp and the prism plate and remove 90° prism.

g. Remove four screws from the support ring and lock ring and remove rings.

h. Headless pins are not removed, unless replacement is required. They may be pressed out.

i. To replace candelabra base socket, unsolder copper wire connecting both sockets and copper wire connecting one socket to contact ring and remove two wires and two sockets.

62. In-Process Inspections and Repair

a. General. Acceptance of the assembled head depends largely upon the care exercised during inprocess inspections and repair.

b. Prism. Inspect prism for cracks and scratches. Replace prism, if damaged.

c. Candelabra Base Socket. Inspect socket for broken coils. Replace socket, if damaged.

63. Assembly

a. Press in two ¼ x ¼ straight headless pins in tube, if replacement is required. Position lock ring and support ring, in order, on insulated end of tube and secure with four No. 0–80 x 3/16 cross-recess flat-head screws in each. Install contact ring between above rings. Contact ring is held by spring tension.

b. Replace two candelabra base sockets in prism mount, if required, and connect No. 20 copper wire between sockets. Solder 2-inch piece of No. 20 copper wire to one socket, to be

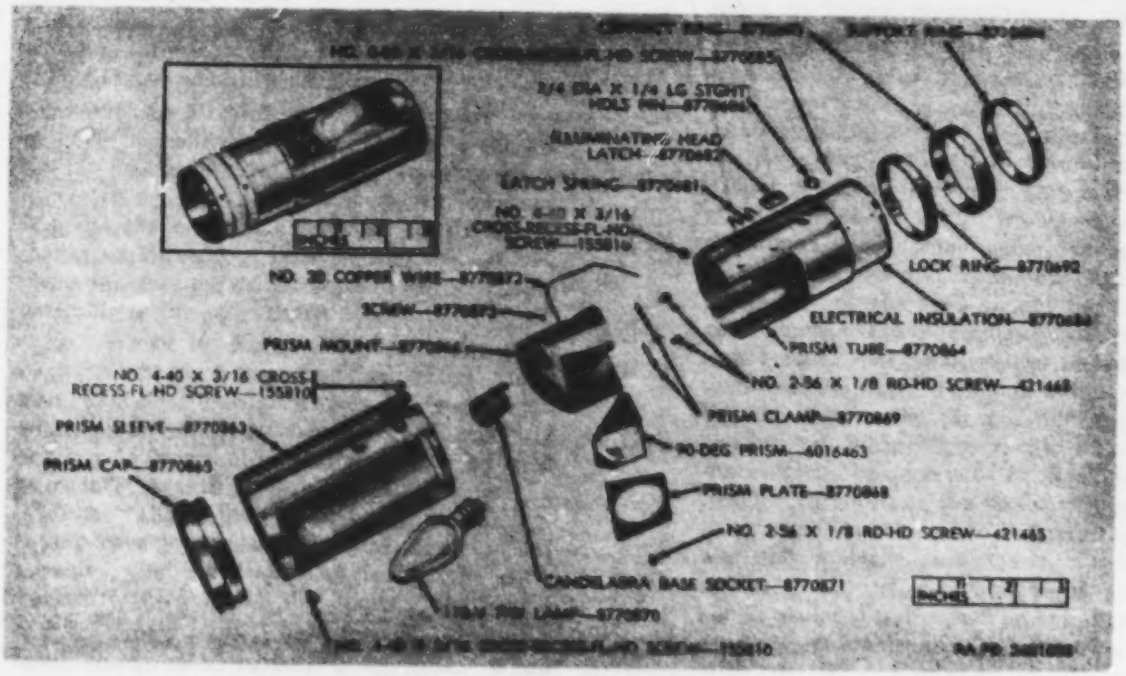


Figure 63. Prism illuminating head assembly—exploded view.

later connected to contact ring. Secure sockets with No. 0–80 x 1/16 hexagon-socket headless setscrew in each.

c. Install 90° prism in prism mount. Position prism plate over prism and secure with two No. 2–56 x 1/8 round-head screws. Install two prism clamps on mount and secure with two No. 2–56 x 1/8 round-head screws in each. Install mount in tube and run free end of 2-inch copper wire through tube and solder end to contact ring. Secure mount with two No. 4–40 x 3/16 cross-recess flat-head screws.

d. Position latch spring and illuminating head latch in groove in tube and install tube as assembled into prism sleeve. Secure with six No. 4–40 x 3/16 cross-recess flat-head screws.

e. Install two 110-volt 7-watt lamps in sockets.

f. Install prism cap on sleeve and secure with one No. 4–40 x 3/16 cross-recess flat-head screw.

CHAPTER 5
DEPOT MAINTENANCE INSTRUCTIONS

Section I. GENERAL MAINTENANCE

64. General

a. This chapter contains general maintenance information and, also, specific maintenance that must be done by ordnance personnel.

b. Information and instructions are supplementary to instructions for the using organization contained in previous chapters.

65. General Methods

a. Tools. Use only wrenches that fit snugly on parts. Tools that do not fit will fail or cause damage to the corners of bolt heads, nuts, screws, etc.

b. Handling of Disassembled Parts. A parts tray or suitable receptacle should be provided so that parts, as removed, can be placed in their respective positions in relation to the assembled borescope. Always keep the relative position of parts until the borescope is completely assembled. This is especially important where a different technician assembles the unit than the one who disassembled it.

c. Scribing Metal Parts. As each part is removed, its exact position in relation to the assembly should be established by suitably scribing reference marks if it is necessary to return it to its exact original position. Never scribe marks on threads or bearing surfaces. When removing mating gears, scribe each gear and assemble in the same position.

d. Removal of Burs. Movable components of the borescope must operate smoothly. Small burs can be removed with a knife-edge oilstone. Short, light strokes should be used. If the bur is large, a jeweler's file can be used to reduce it until it is practicable to use an oilstone. Clean part after filing or honing, taking care to remove all metal particles and abrasive, and lubricate and install the component in the assembly.

e. Handling Optics as Removed. Never touch the polished surface of an optic. When optics are to be laid aside, each must be wrapped in a piece of lens tissue paper. When storing optics, always clean and wrap them completely in lens tissue paper.

f. Marking of Optical Elements (fig. 64).

(1) *General.* The marking of optical elements has a threefold purpose. It aids in the assembly of an instrument by indicating the original position of each element in relation to other elements. If it is necessary to decement compound lenses, a mark of some nature on the edge of the lens aids in cementing the lens in its proper relationship to the mating parts. It enables the repairman to indicate the properties or characteristics of an element. The marking of these elements should be uniform throughout all shops to insure recognition by any instrument repairman.

(2) *Lenses.* The prime purpose for marking lenses upon disassembly is to establish a guide by means of which the lenses can be assembled in their proper relative positions. This mark should consist of a "V" inscribed on the unpolished surface (edge) across all the elements of a compound lens. The point of the "V" should be directed toward the objective end of the instrument. All lenses of an instrument will be marked in this manner, thereby eliminating the possibility of assembling lenses incorrectly. The marking can be done with an indelible pencil. In addition, the lenses will be lettered and numbered to indicate the assembly and the sequence in which example, all the components of an they are placed in the instrument. For eyepiece assembly should be marked with an "E." Eyelenses should be marked "1," field lenses "2," etc. The

numbering system aids in preventing improper placement of the lenses that are similar in appearance and easily mistaken for each other.

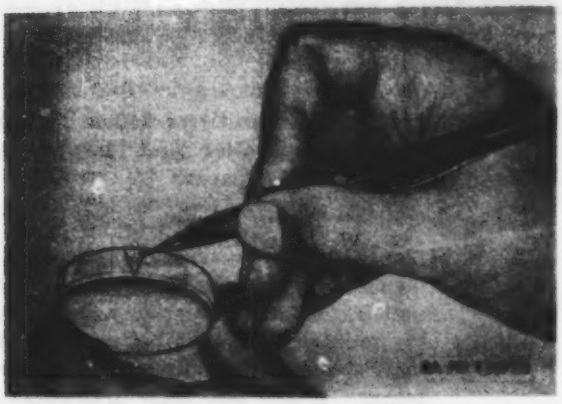


Figure 64. Lens marking system.

g. Removal of Retaining Rings and Barrel.

(1) Retaining rings may be sealed with shellac or sealing compound or may be held with a setscrew. The application of alcohol to the shellac holding a retaining ring may be sufficient to soften the shellac and permit the removal of the ring. However, when the alcohol will not penetrate, the flame of a small alcohol blow torch applied to the outer diameter of the cell, in the area of the retaining ring, will burn or singe the shellac enough to allow removal of the ring.

(2) In the case of objectives where the sealing compound is usually heavily applied, the excess compound should be removed by picking or scraping without damaging the thread. Threads protruding beyond the retaining ring should be cleaned with the correct thread chaser. Solvent should then be applied to the thread to permit softening of the compound that has penetrated under the retaining ring. The ring may then be removed.

h. Removal of Lenses From Barrel. To remove lenses from barrel with threaded retainers, remove the retaining ring setscrews, fit the proper size tubular wrench on the retaining ring and loosen the ring. When the ring has made one revolution, turn the barrel over and gently tap to allow the lens to drop on the retaining ring. Maintain this inverted position while removing the ring; the lens will drop down evenly as the ring is removed. This will prevent cocking of the lens in the cell and subsequent fracturing or chipping of the lens. If the lens and ring are sealed with sealing compound, heat the barrel with a hot plate. If gravity is insufficient to release the sealed lens, back off the retaining ring several turns. Place the barrel upon clean lens tissue paper and, utilizing several folds of lens tissue paper to prevent smudging, apply finger pressure to the top lens until the seal is broken.

i. Installing Optical Elements.

(1) Hold the retaining ring in a horizontal position and place all the components of the optical assembly in their respective positions on the retaining ring. Place cell or barrel down over components and screw in retaining ring. Secure ring with headless screw. In some instruments, it may be necessary to install components individually. In this case, cover the end of the finger with lens tissue paper, place the optical element on the paper, and slide cell over optical element and finger. Be sure that the optical element is firmly seated against the shoulder of the cell, then carefully tip the cell over and install the retaining ring and secure with headless screw.

(2) In general, repairmen are inclined to tighten retaining rings for optical parts too tight, thus distorting the optical elements within the assembly. Do not attempt to hold an assembly in position by tightening any retaining ring beyond the point where it should finally rest. If the definition of an instrument has deteriorated since its repair, it is probable that a retaining ring is too tight or an optical element is not in its proper position.

j. Sealing and Cementing.

(1) *Purpose.* The purpose of sealing optical instruments is to prevent the entrance of moisture, dust, fungus, or

mold. External optical elements, cells, joints, and screw heads must be sealed airtight and watertight, in order to provide protection for all internal optical elements and, at the same time, must be fairly easy to disassemble. It is, therefore, necessary that the sealing compound be removable under conditions that are not injurious to the components of the instrument. All optical elements, which require cementing at time of rebuild, will be cemented with the latest type thermosetting cement. Optical elements cemented with a thermoplastic cement will not be used for rebuild.

(2) *Sealing and cementing materials.*

(*a*) Optical lens sealing compound is used for sealing all eyelenses and objective lenses within their cells and for sealing between metal parts.

(*b*) Plugging or sealing cement is used for sealing all setscrew holes over countersunk fillister-head screws and for sealing closed holes or exterior screws where hiding or filling is necessary.

(*c*) Aircraft and instrument lubricating grease is used for lubricating optical instruments.

(*d*) Orange shellac varnish is used for cementing screws, cells, and other metal parts in place.

(*e*) Synthetic rubber cement, class A and class B, is used for cementing prisms to prism shelves.

(*f*) Refer to ORD 3 SNL K–1 for lubricants and preserving materials and TM 9–1501 for repair of coated optics.

Section II. BORESCOPE M1

66. General

a. Borescope M1 is composed of the eyepiece assembly, main tube assembly, illuminating head assembly, and the lighting transformer assembly.

b. The illuminating head assembly requires no depot maintenance.

67. Eyepiece Assembly

a. General. The eyepiece assembly components are illustrated in figure 65. The principal parts are the sleeve, the pinion housing, the rack, the barrel, lenses, and eyeshield.

b. Disassembly.

(1) Release the clamp screw and remove eyeshield and clamp from barrel assembly.

(2) Unscrew the barrel assembly from the rack. Unscrew the retainer from the barrel and remove field lens, separator, and eyelens. Scribe the lenses (par. 65*f*).

(3) Remove the pinion housing by removing the four screws that secure it to the sleeve. The pinion housing is disassembled to two knobs, two flanges, the pinion, and housing. Drive out the tapered pins that lock the knobs to the pinion and remove two pins and two knobs. Unscrew the three screws that secure each flange to the pinion housing and remove two flanges and pinion from housing.

(4) Remove the pilot screw from the sleeve. Remove the small screw from the pilot screw. Replace the headless pin in the sleeve, if damaged.

(5) Withdraw rack from sleeve and remove eyepiece shoe from groove in sleeve.

c. Repair.

(1) Replace damaged parts. Refer to TM 9–1501 for decementing and cementing of coated optics.

(2) Clean all parts except lenses with a lint-free cloth. Lens cleaning liquid soap should be used to wash coated lenses. Wash gently, while submerged, with a piece of clean celanese cloth. Rinse in warm distilled water. Remove the lens from the water and spray it with acetone. The acetone will remove the water and then evaporate without leaving a film. If the lens is cemented, the immersion process described above cannot be used. The liquids must be applied to the surface of the lens with a brush, taking care not to allow them to come

in contact with the cemented edges of the lens. Lenses may also be cleaned with ethyl alcohol. Avoid getting alcohol on the edges of cemented lenses.

(3) Refer to paragraph 65 for general maintenance.

d. Assembly.

(1) *Barrel assembly.* Position the eyelens, separator, and field lens, as marked at disassembly, into the barrel. The small opening in the separator is against the eyelens. Screw the retainer in the barrel until it is flush with the barrel. Replace 0.50 x 0.125 headless pin in sleeve, if removed. Install the barrel assembly in the rack.

(2) *Rack.* Install rack in the sleeve and insert eyepiece shoe in rack opening. Position it under pilot screw opening. Install pilot screw in sleeve and insert No. 0–80 x 5/32 cross-recess flat-head screw in head of pilot screw.

(3) *Pinion housing.*

(*a*) Install pinion in pinion housing and install a flange over each end of pinion and secure to housing with three No. 2–56 x 1/4 screws in each flange.

(*b*) Position knob on each end of pinion and secure to pinion with one No. 5/0 x 5/8 tapered pin in each. Lightly grease pinion and rack teeth.

(*c*) Install housing as assembled on sleeve and secure with four No. 4–40 x 1/4 cross-recess pan-head screws.

(*d*) Install the eyeshield on the barrel and secure with clamp and one No. 4–48 x 3/16 fillister-head screw.

68. Main Tube Assembly

a. General. The borescope main tube assembly components are shown in figures 66, 67, and 68. The major components are: main tube with collector assembly, inside the main tube are, on tube "A," four tubes "B," one tube "C," one tube "D," and a contact tube; also five erector lens assemblies 8770579 and one erector lens assembly 8770583. Two brass ribbons stretch from a sleeve in front of tube "A" to a clamping ring in front of the contact tube.

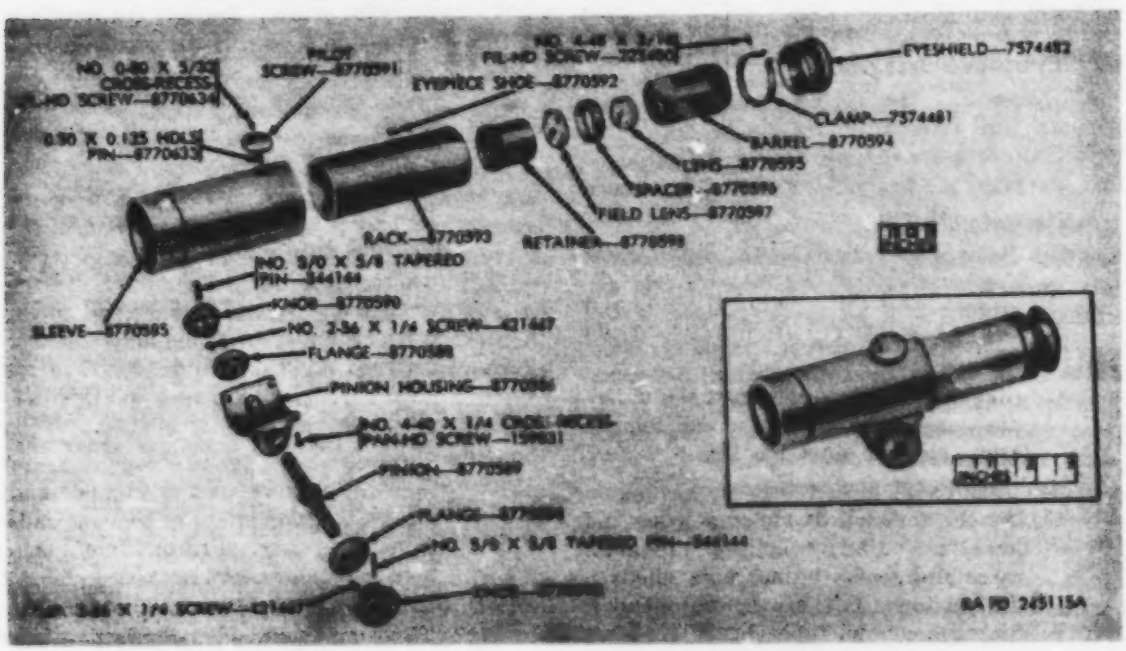


Figure 65. Eyepiece assembly—exploded view.

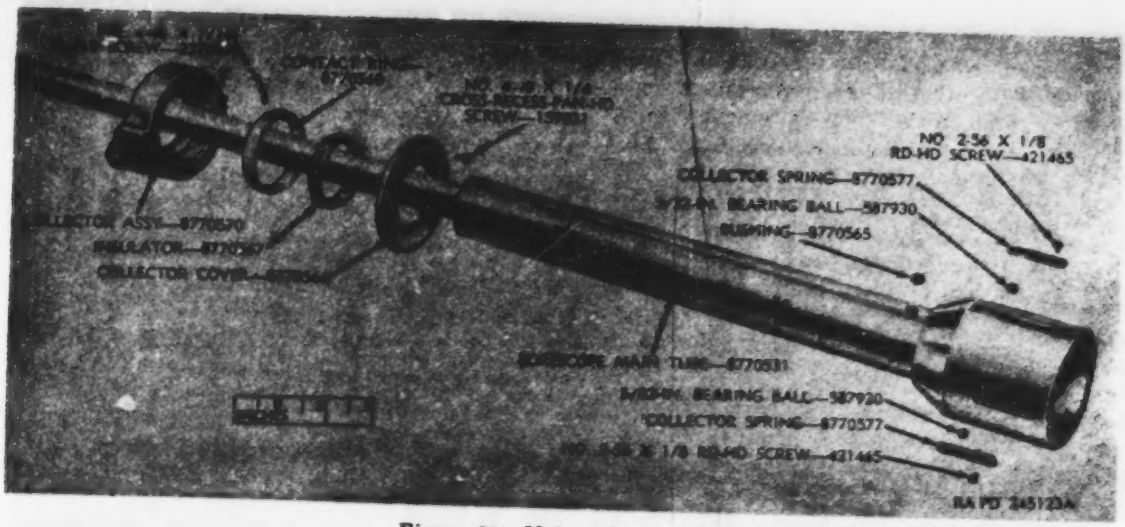


Figure 66. Main tube assembly.

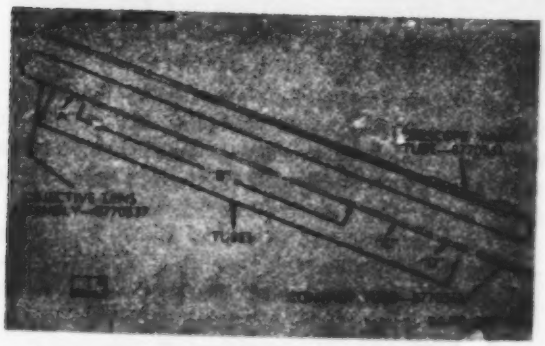


Figure 67. Main tube—partial exploded view.

b. Disassembly of Main Tube.

(1) Remove the four screws that secure the collector cover (fig. 66), four screws that secure the contact ring and insulator, and four bushings imbedded in the outside of the tube and remove the collector assembly from the main tube.

(2) Remove one setscrew from the objective end of the main tube and remove the ring and objective lens assembly (fig. 67).

(3) Insert a 1-inch diameter wooden rod into the objective end of the main tube and push the contents about 6 inches towards the eyepiece opening. Remove contact tube (fig. 67). With the help of an assistant remove the components shown in figure 68 from the main tube. Keep the ribbons taut and mark the components for ease of assembly. The first erector lens assembly withdrawn is different from the others and has its threaded end facing the objective lens. The other five are alike but are placed in the main tube with their threaded ends facing in alternate directions. By supporting the various tubes as the components are removed, it is possible to remove the assembly intact. A hoop supports each erector lens assembly on the taut ribbons.

(4) A brass spacer 8770877, not shown in figure 68, must be used between the sleeve and tube "A." It shall be modified in thickness so as to maintain the final image formed by an axial object 5 feet or more from the objective end between 0.400 inch and 1.000 inch beyond the eyepiece end of this assembly.

(5) Unscrew two screws from each of the two collector springs (fig. 66) and remove springs and two bearing balls from main tube. Pry out four bushings from outside main tube.

c. Disassembly of Objective Lens Assembly.

(1) The components of the objective lens assembly are shown in figure 69.

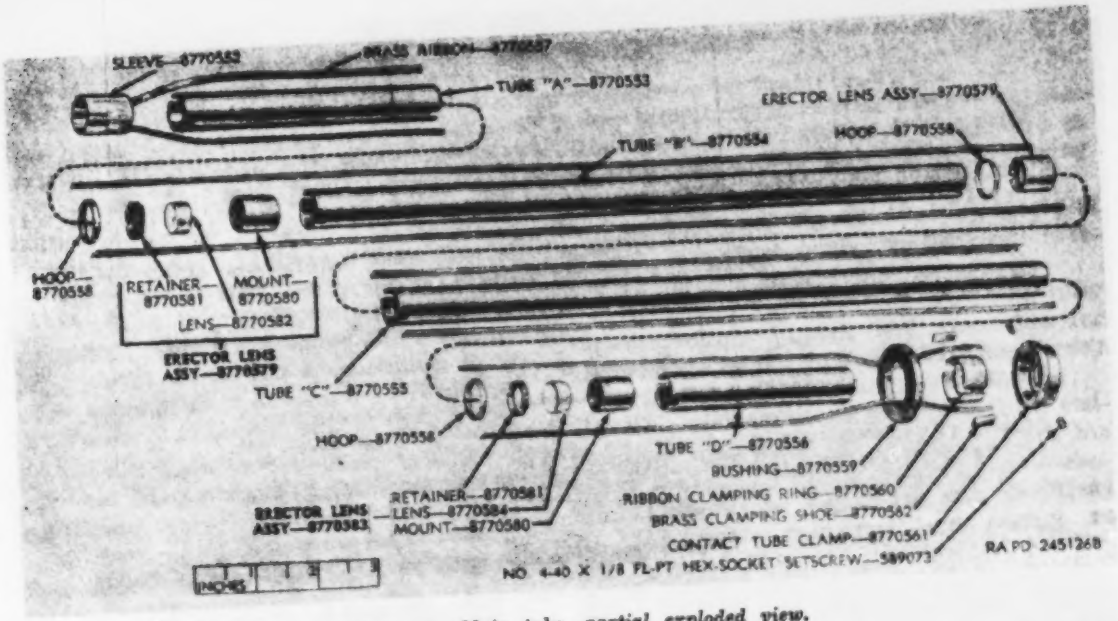


Figure 68. Main tube—partial exploded view.

(2) Break the cement seal between the threads of the cover glass and the barrel threads and remove cover glass and spring. Remove and mark spacer, rear lens, washer, and middle lens. From other end of barrel remove front lens and preformed packing. Remove collar from outside of barrel.

d. Disassembly of Erector Lens Assembly. Remove retainer from threaded end of mount and withdraw erector lens. Mark components for ease of assembly. Components should not be interchanged between like assemblies.

e. Disassembly of Collector Assembly. The parts of this assembly are not illustrated as they are similar to those used in the collector housing of the adapter tube assembly (par.

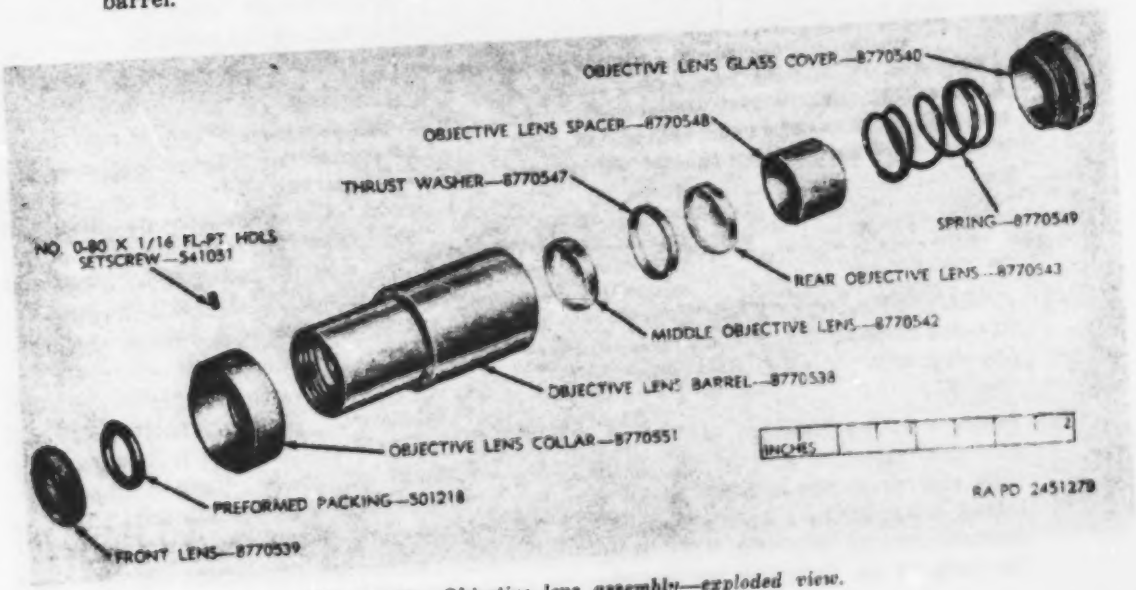


Figure 69. Objective lens assembly—exploded view.

73) (fig. 72) on the borescope M2. Unsolder the wire from the collector spring and remove two screws and the spring. Remove three screws from the mount and remove mount and grounding spring. The grounding spring is held in place by one of the mount screws. Loosen the locknut on the plug connector and remove connector.

f. Repair. Refer to paragraph 67*c*.

g. Assembly of Erector Lens Assembly (fig. 68). Install lens in mount, in position marked at disassembly. Be sure lens is not cocked and is against shoulder on mount. Install retainer and tighten until it contacts lens surface. Wrap in tissue paper until used for installation in main tube.

h. Assembly of Objective Lens Assembly.

(1) Install middle lens through large end of barrel up against shoulder, convex surface facing operator.
(2) Install thrust washer up against lens.
(3) Install rear lens, convex surface facing operator, up against washer.
(4) Install spacer and spring in order and secure in barrel with mounted cover glass. Brush methacrylate cement on the last two threads of the cover glass before securing in place.
(5) In open end of barrel, install preformed packing and front lens.
(6) Install collar over front of barrel and secure in place with one No. 0–80 x 1/16 flat-point headless setscrew.

i. Assembly of Collector Assembly. Position the mount in the housing so that the two tapped holes for the collector spring are under the connector opening and lightly install three No. 2–56 x 1/4 flat-head screws. Install the collector grounding spring in the small diameter of the housing with its legs over the screw opposite the plug connector opening. Secure the three flat-head screws. Install the collector spring on the tapped holes in the mount and secure with two No. 2–56 x 1/8 round-head screws. Assemble and install the plug connector in its opening and carefully solder the No. 20 copper wire on the collector spring. Assembly will be completed after installation on main tube as described in *j*(5), (6), and (7) below.

j. Assembly of Main Tube.

(1) Make certain the erector lens assemblies are in correct order. They are assembled facing alternate directions starting with the assembly nearest the objective end with its threaded end toward the eyepiece.

Note. The external appearance of all lens assemblies is alike but the final assembly (8770583) nearest the eye end has twice the focal length and must be used in this location.

(2) Solder the ribbons to the sleeve and aline the components, shown in figure 68, on a bench as follows: Sleeve, spacer (not shown), tube A, and erector lens assembly with threaded end toward eyepiece. Run the ribbons in the grooves of tube A and place a hoop over ribbons at erector lens assembly, do this for all tubes and lens assemblies. Continue with tube B, lens assembly, and hoop, until four of each are alined in order. Be sure the threaded ends of the lens assemblies face in alternate directions, beginning with the first assembly. Next aline one tube C, lens assembly, hoop, and tube D in order. This last lens assembly is the one with double focal length and it must have its threaded end facing the objective end if lens alinement is correct. Check the alinement of all components. Install bushing over the ribbons. Install the ribbons in the grooves of the ribbon clamping ring. Install brass clamping shoe over each ribbon in groove of ring. Install contact tube clamp over tube clamping ring and secure with two No. 4–40 x 1/8 flat-point hexagon-socket setscrews. See that ribbons are taut before securing setscrews. Bend ends of ribbons away from optical path. Aline contact tube (fig. 67) over the ends of the ribbons and up against the shoulder of the clamp, orient its four tapped holes to line up with the bushing openings in the main tube.
(3) Install the components, as assembled, through the eyepiece opening of the main tube and seat.
(4) Install the objective assembly in the small end of the tube, orienting the

tapped opening in the collar with the opening in the main tube. Secure assembly with lock ring and one No. 0–80 x 1/16 flat-point headless setscrew. Install two 5/32-inch bearing balls in the spring grooves on the large end of the main tube. Secure balls with two collector springs and two No. 2–56 x 1/8 round-head screws in each spring.

(5) Install collector cover on outside of main tube and position up against bevel on tube.

(6) Install four bushings in main tube and install insulator and contact ring over these bushings and secure both with four No. 4–40 x 7/16 flat-head screws.

(7) Install collector housing over main tube up against cover and secure cover on housing with four No. 4–40 x 1/4 cross-recess pan-head screws.

69. Lighting Transformer

a. Description. The components of the lighting transformer are shown in figure 70. The major components consist of a transformer (converting 110 volts primary to 6.3 volts secondary), housing, power cord, and output cord.

b. Test. Connect the transformer to a 110-volt power source and test transformer primary with voltmeter. Test secondary for 6.3 volts output. Test toggle switch on output cord in open and closed positions. Test cords for continuity.

c. Disassembly. Remove two screws from housing cover and remove cover and rubber gasket, if used. Remove two screws from bottom of housing and withdraw transformer, two nuts, and two lockwashers. Tag and disconnect the power cord wires to the transformer and the secondary wires to the female receptacle and ground in housing. Remove female receptacle.

d. Repair. Replace cords, if cables are broken. Replace transformer, if defective. Replace transformer housing, if cracked. Replace toggle switch, if damaged or worn. Replace female receptacle, if threads are worn or receptacle is damaged.

e. Assembly. Install female receptacle in place and secure with lock nut. Install 1/2-inch connector on free end of power cord and install cord through shouldered opening in hous-

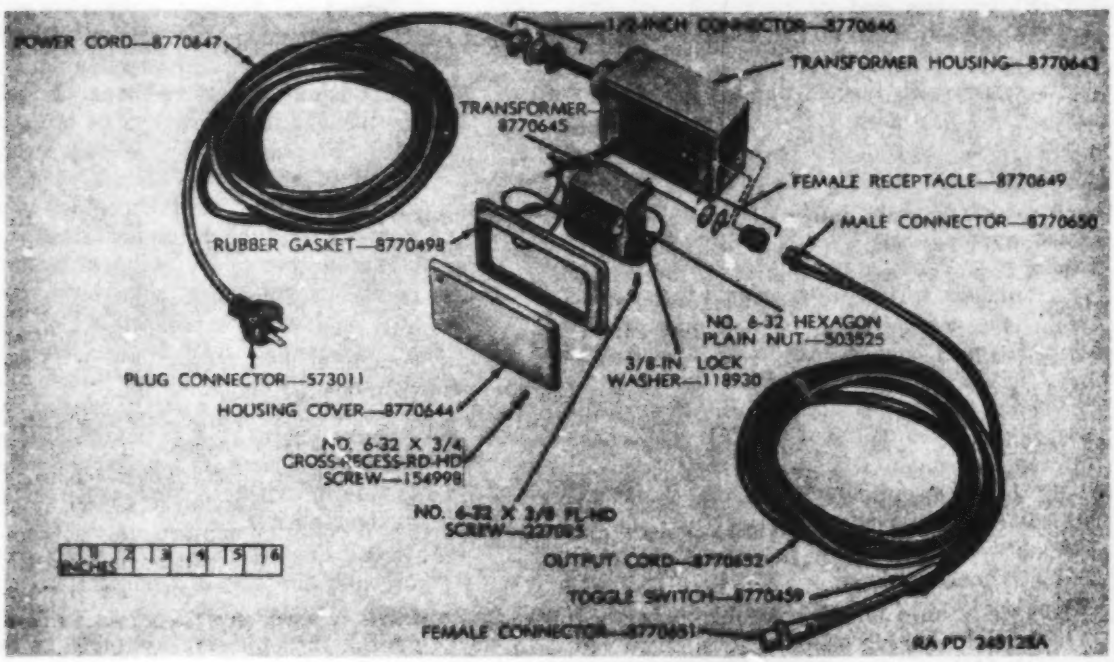


Figure 70. Lighting transformer—exploded view.

ing. Connect ends of power cord to transformer primary. Position transformer in housing and connect one secondary wire to female receptacle and the other to ground. Secure transformer to housing with one No. 6–32 x ⅜ flat-head screw through housing and each lug of transformer. Secure screws with one ⅜-inch lock washer and one No. 6–32 hexagon plain nut on each. Install rubber gasket on cover, if used, and install cover and secure with two No. 6–32 x ¾ cross-recess round-head screws. The output cord is connected between transformer and borescope.

70. Assembly and Final Inspection of Borescope M1

a. Install eyepiece assembly in large opening of main tube assembly. Focal adjustment is obtained through operating either of two knobs on the eyepiece. A knurled screw is provided to lock assembly in focus.

b. Look through the eyepiece and check for dirt, smears, scratches, condensate, chips, fractures, and cement separations.

c. Surface of objective lens and eyelens may be cleaned with ethyl alcohol. Dry with clean lens tissue paper. Lens cleaning liquid soap should be used to clean coated lenses.

Section III. BORESCOPE M2

71. General

Borescope M2 is composed of the eyepiece assembly, adapter tube assembly, three extension tube assemblies (numbered I, II, and III), objective tube assembly, three illuminating head assemblies, and a power supply. No depot maintenance is performed on the illuminating head assemblies.

72. Eyepiece Assembly

a. The eyepiece assembly used is similar to that used on borescope M1.

b. For detailed information on eyepiece assembly, refer to paragraph 67.

73. Adapter Tube Assembly

a. Description. The adapter tube assembly (fig. 71) is used to receive the eyepiece assembly on one end and to connect the other end directly to the objective tube assembly or to any extension tube assembly (I, II, or III) that may be used singly or in combination with the objective tube assembly. The collector housing is part of the adapter tube assembly on the borescope M2 but it is part of the main tube assembly on the borescope M1.

b. Disassembly.

(1) Remove four screws that secure the tube adapter cover to the collector housing (fig. 72) and remove cover and housing. Mark the eyepiece end of the remaining rings, as the insulating ring is drilled offcenter. Remove four screws, collector contact ring, insulating ring, and four bushings from outside the adapter, and the tube adapter sleeve and the tube adapter insulator from inside the adapter. Electrical insulation (tape) is not removed from the insulator.

(2) Unsolder wire from collector spring and remove two screws and the collector spring. Remove three screws, the tube adapter mount, and two collector grounding springs. These grounding springs are located 180° apart. Loosen locknut on plug connector and remove connector. Remove two screws from each collector spring on outside of adapter and remove two springs and two bearing balls.

c. Repair. Replace plug connector, if bent or damaged. Replace No. 20 copper wire, if broken. Clean dust from housing. Replace collector springs, if broken or cracked. Replace bearing balls, if damaged.

d. Assembly.

(1) Install tube adapter sleeve in insulator and aline holes; install insulator in adapter and aline holes in sleeve with bushing holes in adapter. Install four tube adapter bushings through outside of tube. Position insulating ring over adapter bushings, marked end toward eyepiece opening; install collector contact ring over insulating ring (it must overhang it). Install four No. 4–40 x ⅛ brass cross-recess flat-head screws through alined holes until their ends are installed in sleeve on inside of adapter.

(2) Install tube adapter mount (fig. 72) in adapter collector housing and loosely secure with three No. 2–56 x ¼ flat-head screws. Beginning on the left side of the plug connector opening, install a grounding spring over the two screws 180° apart and tighten all screws. Position the collector spring on the mount and secure with two No. 2–56 x ⅛ round-head screws. Screw the plug connector into its opening and solder the end of the wire to the collector spring. Install the housing over the objective end of the adapter and the cover over the eyepiece end and secure the cover on the housing with four No. 4–40 x ⅜ cross-recess pan-head screws. Install two

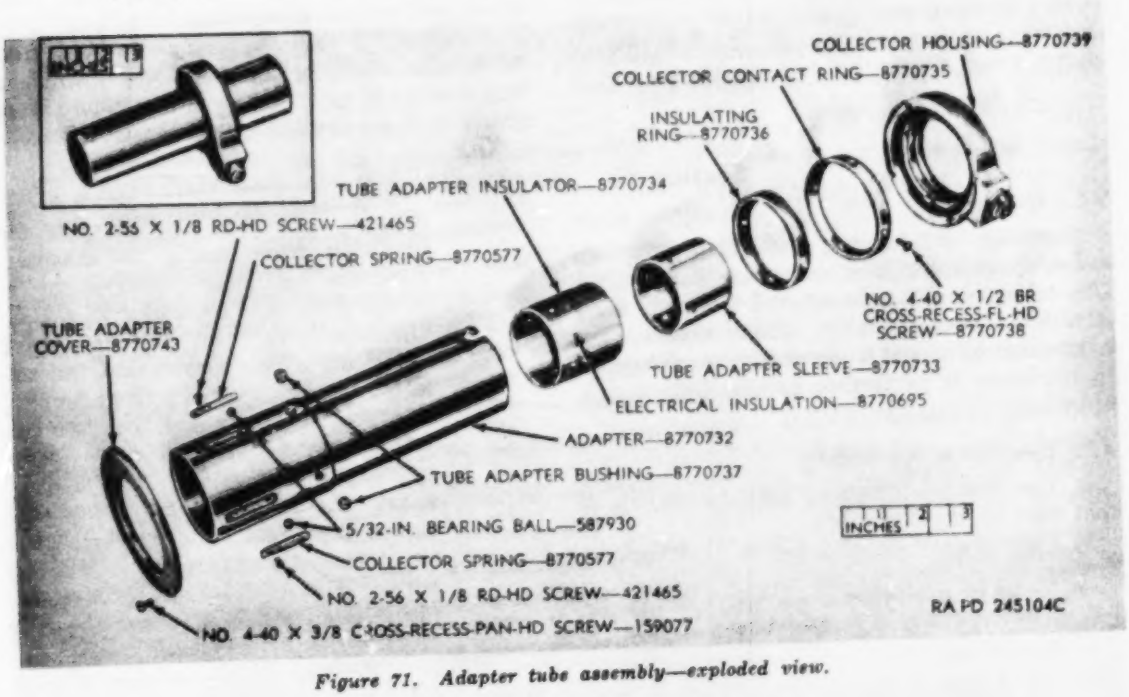


Figure 71. Adapter tube assembly—exploded view.

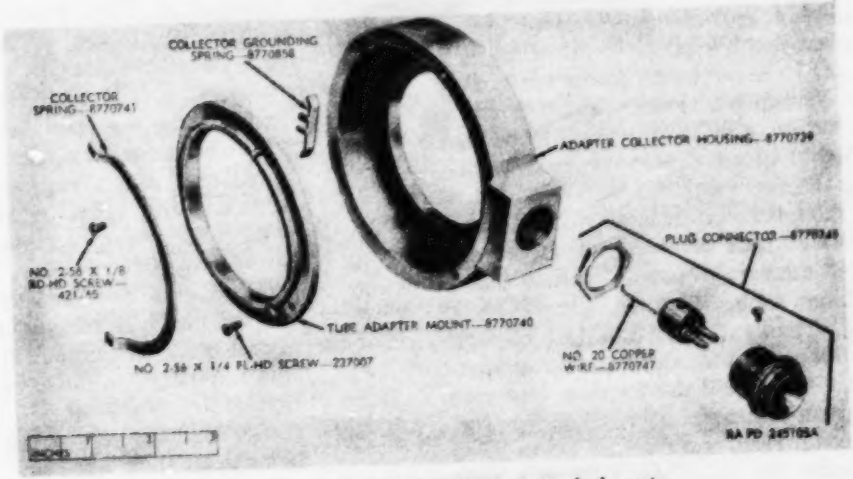


Figure 72. Collector housing w/attached parts.

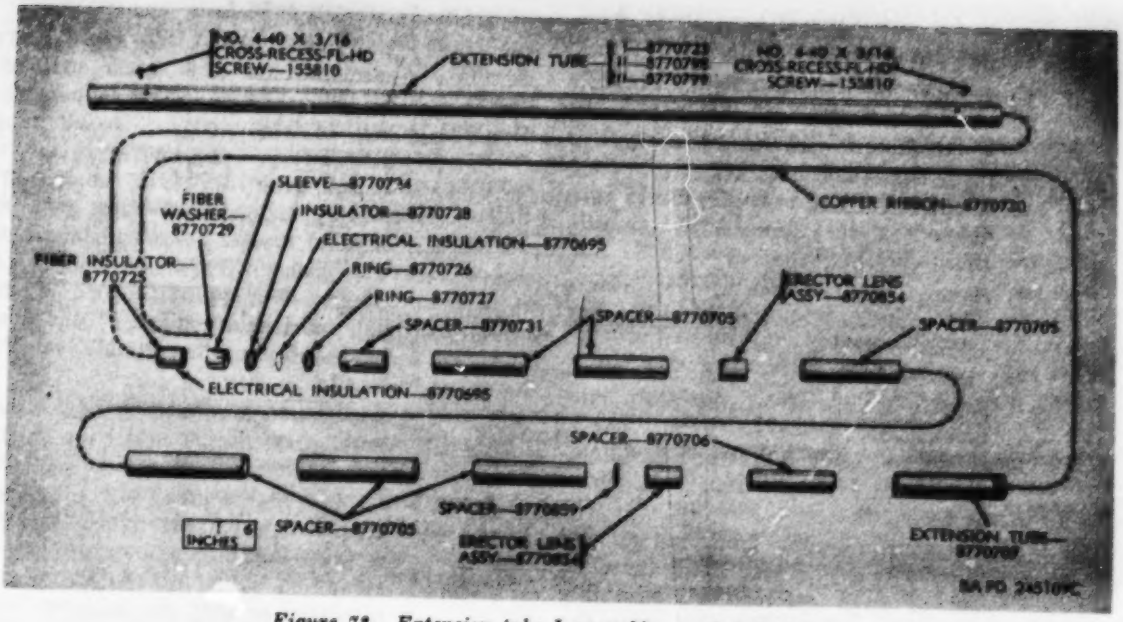


Figure 73. Extension tube I assembly—exploded view.

5/32-inch bearing balls in spring openings on outside of adapter and install a spring in each opening. Secure each spring with two No. 2–56 x 1/8 roundhead screws.

74. Extension Tube I Assembly

a. General. The components of extension tube I are shown in figures 73, 74, and 75. Extension tubes I, II, and III, used on the borescope M2, are alike in construction and are all handled in the same manner. The major components of each are extension tube I, II, or III, extension tube, two erector lens assemblies, eight tubular spacers, one (ring) spacer, one sleeve with two rings, a copper ribbon, and two insulators with their electrical insulation (tape).

b. Disassembly.

(1) Unsolder the copper ribbon from the contact ring on the extension tube.

Note. Avoid softening the support ring and lock ring.

(2) Remove eight screws that secure extension tube I assembly to the extension tube (fig. 74).

(3) Remove the extension tube from extension tube I. Do not lose the illuminating head latch, latch spring, and extension tubes retainer that are in grooves on the extension tube.

(4) Remove four screws from the end of the extension tube and remove support ring.

(5) Remove contact ring and four screws from illuminating head lock ring and remove lock ring.

(6) Remove two screws from contact spring on inside of tube and remove spring.

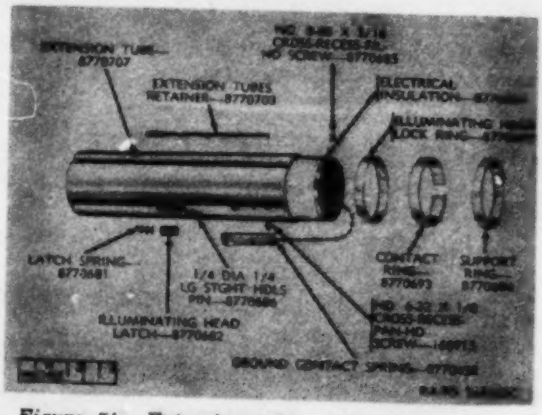


Figure 74. Extension tube with attached parts removed.

(7) Press out headless pin, if replacement is required.

(8) Remove four screws from opposite end of extension tube I and insert wooden plug with flat clearance for ribbon into extension tube end of extension tube I and push contents until fiber insulator appears at opposite end.

(9) Remove fiber insulator and sleeve with soldered ribbon. Avoid bending ribbon.

(10) Remove insulator with insulation, ring with insulation, and plain ring from sleeve.

(11) Push spacers and erector lens assemblies from extension tube I as shown in figure 73.

(12) Remove retainer from mount and remove erector lens. The threaded end of each erector lens assembly faces in opposite direction, with the lens nearest the extension tube facing that tube.

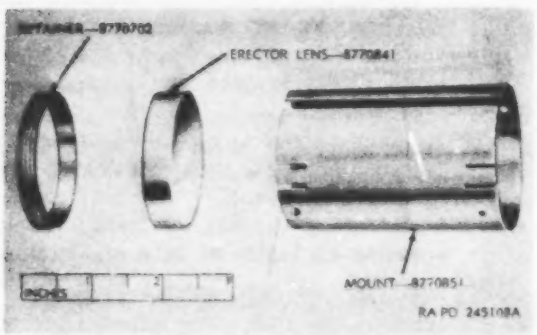


Figure 75. Erector lens assembly (8770854)—exploded view.

c. Repair.

(1) Replace damaged parts. Refer to TM 9–1501 for decementing and cementing of coated optics.

(2) Refer to paragraph 67*c*(2) for cleaning procedure.

(3) Refer to paragraph 65 for general maintenance.

d. Assembly.

(1) *Erector lens assembly.* Install erector lens in threaded end of mount and secure with retainer.

(2) *Extension tube I.*

(*a*) Extension tubes I, II, and III are assembled in the same manner. Solder one end of the copper ribbon to the sleeve. Install ring 8770726 against shoulder in sleeve. Install ring 8770727, tapped end leading, up against other ring so that its tapped holes will be alined with holes in extension tube I. A washer is installed in each of the holes and held in place by the fiber insulator on the outside of the sleeve.

(*b*) Lay extension tube I horizontal, with the engraved centerline on the bottom. Install the sleeve in the fiber insulator and place the other insulator over the rings in the sleeve. Push the ribbon into extension tube I, holding the sleeve and insulator so that the soldered connection is on top. Aline sleeve holes with holes in extension tube I and install four No. 4–40 x 3/16 cross-recess flat-head screws to clamp the sleeve in place.

(*c*) From the opposite end of extension tube I, pull ribbon taut and install the first tubular spacer, with its groove receiving the ribbon, up against ring of sleeve.

(*d*) In order shown in figure 73, install two tubular spacers, erector lens assembly with threaded end leading, four tubular spacers, and ring spacer. If this ring spacer is replaced, it must be of proper thickness necessary to adjust central space to maintain final erector image of an axial object 8.360 inches inside the objective end at a distance of 3.850 inches minimum to 4.060 inches maximum from the end of tube assembly. Install another erector lens assembly, threaded end following, and then install final tubular spacer.

(*e*) On extension tube (fig. 74), replace a 1/4-inch diameter 1/4-inch long headless pin, if damaged. Install illuminating head lock ring, con-

tact ring, and support ring on insulated end and secure with four No. 0–80 x 3/16 cross-recess fillister-head screws in each. Install ground contact spring, if used, in position inside tube and secure with two No. 6–32 x 1/8 cross-recess pan-head screws. In some models this spring is not used, being replaced with a headless pin in a different position.

(*f*) Position extension tube in eyepiece end of extension tube I and run ribbon taut in its groove. Install extension tubes retainer over ribbon and insert extension tube into extension tube I, installing latch spring and latch as it is inserted. Secure tubes with eight No. 4–40 x 3/16 cross-recess flat-head screws.

(*g*) Solder end of ribbon to contact ring.

75. Objective Tube Assembly

a. General. The components of the objective tube assembly are shown in figure 76. It will be noted that many of the tubular spacers and both erector lens assemblies are identical with those used in extension tubes I, II, and III. The main difference occurs at the objective end, where an objective lens assembly is added and a tubular spacer deleted.

b. Disassembly.

(1) Remove and disassemble extension tube as shown in paragraph 74*b*(1) through (7).

(2) Unscrew objective lens assembly from objective tube.

(3) Unscrew the glass cover (fig. 77) from the objective lens barrel and remove tubular spacer, rear lens, ring spacer, and middle lens. Mark lenses for ease of assembly.

(4) Unscrew front lens from opposite end of barrel and remove preformed packing.

(5) Remove four screws from objective end of tube, and follow instructions in paragraph 74*b*(8) to (12) inclusive, for removal and disassembly of similar components.

c. Repair. Follow instructions outlined in paragraph 74*c*.

d. Assembly.

(1) *Erector lens assembly.* Install erec-

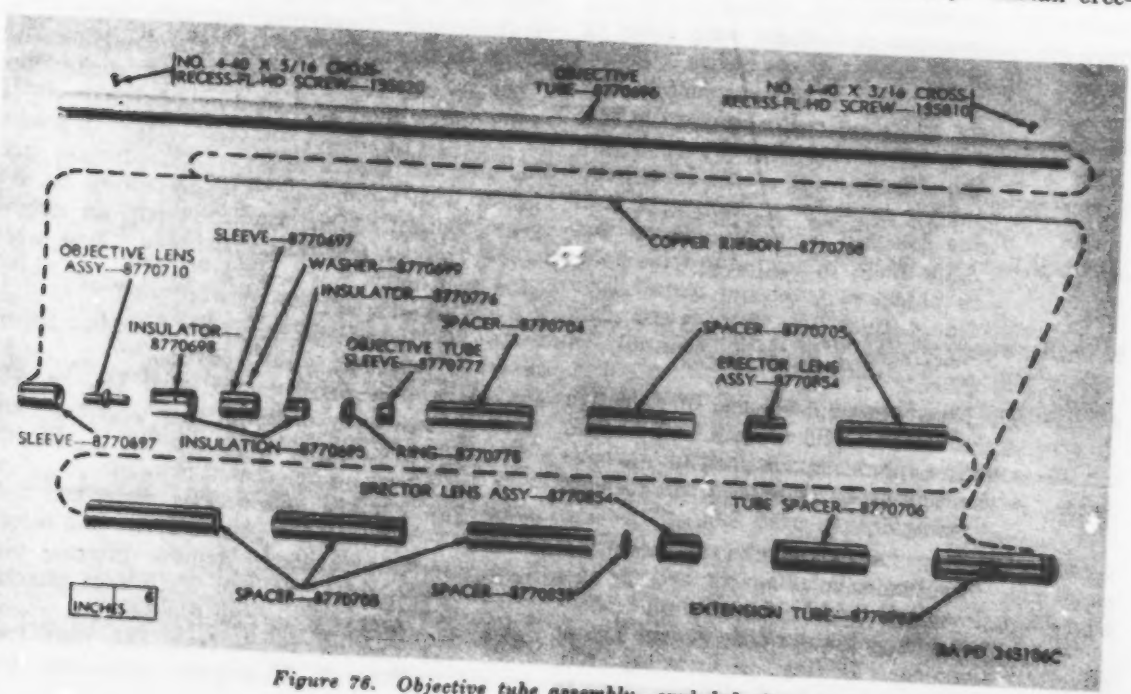


Figure 76. Objective tube assembly—exploded view.

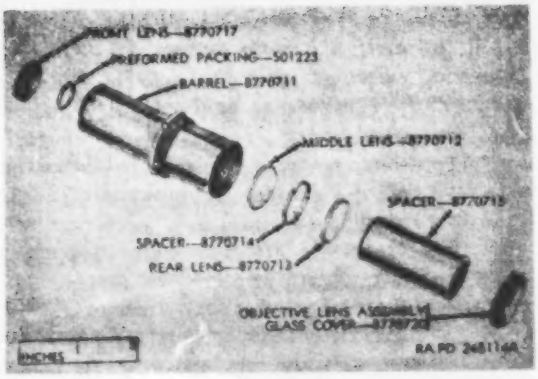


Figure 77. Objective lens assembly—exploded view.

tor lens in threaded end of mount and secure with retainer.

(2) *Objective tube assembly.*

(*a*) Solder end of ribbon to sleeve and install four washers in tapped holes of sleeve. Install sleeve in insulator, alining holes in sleeve and insulator. Install ring, hub leading, in sleeve. Install insulator into sleeve until its end seats over ring and install sleeve in this insulator, threaded end leading, until it seats up against ring. Aline holes in this insulator and sleeve with holes in other insulator and sleeve.

(*b*) Lay objective tube horizontal, with the engraved centerline on the bottom. Push the copper ribbon into the objective end of the tube, holding the insulator and sleeve so that the soldered connection is on top. Aline holes in insulator with holes in objective tube and install four No. 4–40 x 5/16 cross-recess flathead screws to clamp assembly in place.

(*c*) From the opposite end of objective tube, pull ribbon taut and install first tubular spacer, with its groove receiving the ribbon, until it seats up against sleeve.

(*d*) In order shown in figure 76, install another tubular spacer, erector lens assembly with threaded end leading, four tubular spacers, and a ring spacer. If ring spacer is replaced, it must have thickness necessary to adjust central space to maintain final erector image of an axial object 15 feet or more from objective end of tube assembly at a distance of 3.850 inches minimum to 4.060 inches maximum from end of tube assembly. Install final erector lens assembly, threaded end following, and install last tubular spacer.

(*e*) Assemble and install extension tube as outlined in paragraph 74*d*(2).

(3) *Objective lens assembly.*

(*a*) Install middle lens, spacer, and rear lens in position in barrel. The convex surface of the lenses face the operator. Install tubular spacer in barrel until it seats against rear lens. Install mounted cover glass to large threaded opening of barrel.

(*b*) Install preformed packing in groove in open end of barrel and install mounted front lens in this opening.

(*c*) Install assembled objective lens in objective tube.

76. Power Supply Assembly

a. Description. The components of the power supply assembly are shown in figure 78. The major components consist of an isolating transformer, converting 110 volts primary to 6.3 volts secondary, inclosed in a metal box with attached power cord and output cord. The secondary line is protected by a fuse.

b. Test. Connect the transformer to a 110-volt power source and test transformer primary with voltmeter. Test secondary for 6.3 volts output. Test toggle switch, on output cord, in open and closed positions. Test cords for continuity.

c. Disassembly.

(1) Remove eight screws from box covers and remove two covers.

(2) Disconnect power cord (B, fig. 78) from isolating transformer and ground and remove cord. Disconnect electrical output cord.

(3) Remove four screws, nuts, and lockwashers from transformer and receive transformer. Remove internal plug (Q, fig. 78) and disconnect attached wires.

(4) Remove two screws and nuts from 250-volt 10-ampere miniature plug

A—ALLIGATOR CLIP—AF-60-S
B—POWER CORD—8770712
C—POWER SUPPLY BOX—8770771 (COVERS REMOVED)
D—FUSE POST—8770786
E—CARTRIDGE FUSE
F—NO. 6-32 X 1/4 CROSS-RECESS-PAN-HD SCREW—159237
G—250-V 10-AMP MINIATURE PLUG—8770787
H—NO. 18 COPPER WIRE—8770502
J—18 IN. LONG NO. 18 STRANDED COPPER WIRE—8770499
K—7 IN. LONG NO. 18 STRANDED COPPER WIRE—8770501
L—9 IN. LONG NO. 18 STRANDED COPPER WIRE—8770500
M—PLUG CONNECTOR—8770785
N—TOGGLE SWITCH—8770459
P—ELECTRICAL OUTPUT CORD—8770652
Q—OUTPUT CORD CAP—8770783
R—INTERNAL PLUG—8770779
S—NO. 8-32 HEXAGON PLAIN NUT—503526
T—NO. 8 SCREW SIZE LOCK WASHER—541830
U—ISOLATING TRANSFORMER—8770772
V—LINE CORD BUSHING—8770775
W—CORD CONNECTOR CAP—8770911
X—NO. 8-32 X 1/4 CROSS-RECESS-PAN-HEAD SCREW—159574
Y—NO. 6-32 HEXAGON PLAIN NUT—503525
RA PD 245110A

Figure 78. Power supply assembly—exploded view.

and disconnect fuse post wire from plug and remove plug.

(5) Remove fuse post and two attached wires.

d. Repair. Replace defective cords, cables, wires, and plugs. Replace transformer, if defective. Replace defective fuse. Replace toggle switch, if damaged.

e. Assembly.

(1) Install or replace cables and wires on 250-volt 10-ampere miniature plug and install and secure plug with two No. 6–32 x ¼ cross-recess pan-head screws and two No. 6–32 hexagon plain nuts.

(2) Install fuse post in opening and replace fuse, if required. Solder black wire from plug to fuse post terminal and install another black wire between fuse post lug and internal plug. Connect free end of white wire to internal plug.

(3) Install transformer and secure with four No. 8–32 x ¼ cross-recess pan-head screws, four No. 8 screw size lockwashers, and four No. 8–32 hexagon plain nuts.

(4) Install bushing on cord and insert cord in power supply box and secure bushing. Connect black and white cables to primary of transformer and green cable to ground; also connect the other green cable from miniature plug to ground.

(5) Insert internal plug with attached wires in secondary side of transformer.

(6) Install two covers on power supply box and secure with eight screws.

(7) Install electrical output cord in miniature plug.

77. Assembly and Final Inspection of Borescope M2

a. Assemble borescope M2 as outlined in paragraph 12.

b. Look through the eyepiece and check for dirt, smears, scratches, condensate, chips, fractures, and cement separations.

c. Surface of objective lens and eyelens may be cleaned with ethyl alcohol. Dry with clean lens tissue paper. Lens cleaning liquid soaps should be used to clean coated lenses.

APPENDIX

REFERENCES

1. Publications Indexes

The following indexes should be consulted frequently for latest changes or revisions of references given in this appendix and for new publications relating to materiel covered in this technical manual.

Index of Army Motion Pictures, Film Strips, Slides, and Phono-Recordings. DA Pam 108–1

Military Publications:

Index of Administrative Publications. DA Pam 310–1

Index of Blank Forms. DA Pam 310–2

Index of Graphic Training Aids and Devices. DA Pam 310–5

Index of Supply Manuals—Ordnance Corps. DA Pam 310–29

Index of Technical Manuals, Technical Bulletins, Supply Bulletins, Lubrication Orders, and Modification Work Orders. DA Pam 310–4

Index of Training Publications. DA Pam 310–3

2. Supply Manuals

a. Destruction To Prevent Enemy Use.

Ammunition Explosives, Bulk Propellants, and Explosive Devices. SM 9–5–1375

b. General.

Introduction. ORD 1

c. Repair and Rebuild.

Abrasives, Adhesives, Cleaners, Preservatives, Recoil Fluids, Special Oils, and Related Items. ORD 3 SNL K–1

Antifriction Bearings and Related Items. ORD 5 SNL H–12

Miscellaneous Hardware. ORD 5 SNL H–2 and SM 9–1–5340

Pipe, Tubing, and Hose. ORD 5 SNL H–7

Shop Set, Field Maintenance, Ordnance Ballistic and Technical Service Team (41–S–2990–163). ORD 6 SNL J–8, Sec 24

Soldering, Metallizing, Brazing, and Welding Materials; Gases and Related Items. ORD 3 SNL K–2

Standard Electrical Components. ORD 5 SNL H–4

Standard Hardware. ORD 5 SNL H–1

Tool Set, Field, Special, Ordnance Ballistic and Technical Service Team and Cannon Bore Inspection Equipment. ORD 6 SNL J–33

Tool Set, Instrument Repairman (MOS 3922) (41–T–3536–21). ORD 6 SNL J–10, Sec 14

d. Borescope.

Borescope, M1 (For 20-mm–40-mm Cannon Bore Inspection). ORD 8 SNL J–717, Sec 2

Borescope M2. ORD 8 SNL J–717, Sec 3

3. Forms

DA Form 9–13, Weapon Record Book, Part I.

DA Form 9–13–1, Weapon Record Book, Part II.

DA Form 5–31, Shop Job Order Register.

DA Form 9–79, Parts Requisition.

DA Form 9–80, Job Order File.

DA Form 9–81, Exchange Part or Unit Identification Tag.

DA Form 421, Stock Record Card.

DA Form 450, Army Shipping Document.

DA Form 468, Unsatisfactory Equipment Report.

DA Form 865, Work Order.

DA Form 866, Consolidation of Parts.

DA Form 867, Status of Modification Work Order.

DA Form 1546, Request for Issue or Turn-In.

DA Form R–5705, Artillery and Combat Vehicle Inspection Report.

DD Form 6, Report of Damaged or Improper Shipment.

DD Form 250, Materiel Inspection and Receiving Report.

4. Other Publications

a. Camouflage.

Camouflage, Basic Principles ..... FM 5–20

b. Decontamination.

Decontamination ..... TM 3–220

Defense Against CBR Attack ..... FM 21–40

c. Destruction To Prevent Enemy Use.

Explosives and Demolitions ..... FM 5–25

Ordnance Service in the Field ..... FM 9–5

d. General.

Inspection of Ordnance Materiel in the Hands of Troops. TM 9–1100

Logistics (General): Malfunctions Involving Ammunition and Explosives. AR 700–1300–8

Logistics (General): Unsatisfactory Equipment Report. AR 700–38

Maintenance of Supplies and Equipment: Weapon Record Book for Other Than Small Arms. AR 750–1000–8

Military Symbols ..... FM 21–30
AFM 55–3

Military Terms, Abbreviations, and Symbols: Authorized Abbreviations. AR 320–50

Dictionary of United States Army Terms. SR 320–5–1

Military Training ..... FM 21–5

Ordnance Maintenance and General Supply in the Field. FM 9–10

Principles of Artillery: Weapons. TM 9–3305–1

Safety: Accident Reporting and Records. AR 385–40

Safety: Regulations for Firing Ammunition For Training, Target Practice, and Combat. AR 385–63

Techniques of Military Instruction FM 21–6

e. Repair and Rebuild.

Evaluation of Erosion and Damage in Cannon Bores. TB 9–1860–2

Instruction Guide: Care and Maintenance of Ball and Roller Bearings. TM 37–265

Instruction Guide: Welding Theory and Application. TM 9–2852

Maintenance and Care of Hand Tools. TM 9–867

Maintenance of Supplies and Equipment: Maintenance Reponsibilities and Shop Operations. AR 750–5

Ordnance Maintenance: Materials Used for Cleaning, Preserving, Abrading, and Cementing Ordnance Materiel and Related Materials Including Chemicals, Lubricants, Indicators, and Hydraulic Fluids. TM 9–1007

Ordnance Maintenance: Operation and Maintenance of Optical Coating Equipment. TM 9–1501

Standards for Oversea Shipments and Domestic Issue of Ordnance Materiel Other Than Ammunition and Army Aircraft. TB ORD 385

f. Shipment and Standby or Long-Term Storage.

Instruction Guide: Ordnance Preservation, Packaging, Packing, Storage, and Shipping. TM 9–1005

Logistics (General): Report of Damaged or Improper Shipment. AR 700–58

Marking and Packing of Supplies and Equipment: Marking of Oversea Supply. SR 746–30–5

Packaging and Shipping of Materiel: Army Shipping Document TM 38–705

Packaging and Shipping of Materiel: Preservation, Packaging, and Packing of Military Supplies and Equipment. TM 38–230

Storage and Issue of Spare Cannon and Tubes of Limited Service Life. SB 9–115

INDEX

	Paragraphs	Page
Accidents, field report	2*d*	2
Adapter tube assembly	73	58
Assembly of borescopes	Table IV	22
Authorized forms	2*b*	2
Bore magnification	Table V	25
Borescopes:		
M1:		
Assembly and inspection	70	53
Depot maintenance	66–70	47
M2:		
Assembly and inspection	77	59
Depot maintenance	71–77	58
Bore magnification	Table V	25
Description	5	4
Interpretation of views	11*c*, 12*c*	21, 27
Operation (normal):		
M1	11	18
M2	12	21
Service upon receipt	8	16
Burs, removal	65*d*	45
Cleaning and lubricating	24	33
Common tools and equipment	20	32
Components of pullover gages	4	3
Description of materiel	3–6	3
Distorted image	27	34
Extension tube I assembly	74	55
Eyepiece assembly:		
M1	67	47
M2	72	53
Failure of head lamp to light	26	34
Field maintenance instructions	28–63	35
Forms, records, and reports	2	2
Gages:		
Operation:		
Abnormal conditions	13–17	30
Normal conditions	9, 10	17
Pressure gage M3	6	14
Pullover:		
Assembly	36	35
Components	4	3
Disassembly	34	35
Final inspection	37, 38	37
General	33	35
Purpose	3	3
Service upon receipt	7, 8	16
Handling of disassembled parts	65*b*	45
Illuminating head assemblies:		
20-mm gun:		
Assembly	43	38
Disassembly	41	38
General	39	38
Illuminating head assemblies—Continued		
20-mm gun—Continued		
In-process inspection and repair	42	38
Test and adjustment	40	37
37-mm and 40-mm guns:		
Assembly	48	38
Disassembly	46	38
General	44	38
In-process inspection and repair	47	38
Test and adjustment	45	38
Large (105-mm through 280-mm weapons):		
Assembly	58	42
Disassembly	56	41
General	54	41
In-process inspection and repair	57	41
Test and adjustment	55	41
Prism:		
Assembly	63	43
Disassembly	61	43
General	59	42
In-process inspection and repair	62	43
Test and adjustment	60	42
Small (57-mm through 90-mm weapons):		
Assembly	53	40
Disassembly	51	39
General	49	39
In-process inspection and repair	52	39
Test and adjustment	50	39
In-process inspections and repairs. (*See under specific item.*)		
Inspection:		
By using personnel	23	33
Final	37, 38	37
In-process. (*See under specific item.*)		
Inspection of gages	37, 38	37
Lighting transformer	69	52
Lubrication	24	33
Main tube assembly	68	48
Maintenance:		
Depot	64–77	45
Field maintenance instruction	28–63	35
General methods	64, 65	45
Operations:		
Abnormal conditions	13–17	30
Normal conditions	9–12	17
Parts (field)	31	35

	Paragraphs	Page
Maintenance—Continued		
Service upon receipt	7, 8	16
Using personnel:		
Preventive-maintenance service	22–24	33
Spare parts, tools, and equipment	18–21	32
Troubleshooting	25–27	34
Objective tube assembly	75	57
Operating instructions	7–17	16
Operations:		
Service upon receipt	7, 8	16
Unusual conditions:		
Cold climates	14	31
Hot climates	15	31
Pressure gage M3	13	30
Salty atmosphere	16	31
Sandy or dusty	17	31
Usual conditions:		
Borescopes:		
M1	11	18
M2	12	21
Instructions	9	17
Pullover gage	10	17
Optical elements:		
Handling	65*e*	45
Installation	65*i*	46
Marking	65*f*	45
Removal	65*h*	46
Sealing and cementing	65*j*	46
Power supply assembly	76	58
Precautions for operation in abnormal conditions	13–17	30
Pressure gage M3. (*See* Gages.)		
Preventive-maintenance services	22–24	33
Prism illuminating head assembly. (*See* Illuminating head assemblies.)		
Pullover gage stops for artillery weapon inspection. (*See* Table III).		
Pullover gages. (*See* Gages.)		
Pullover gages for artillery weapon inspection. (*See* Table I.)		
Records and reports. (*See* Forms, records, and reports.)		
Removal of burs	65*d*	45
Rod assemblies for artillery weapon inspection. (*See* Table II.)		
Scope of manual	1	2
Scribing metal parts	65*c*	45
Service upon receipt of materiel:		
General	7	16
Inspection and cleaning	8	16
Spare parts	19	32
Special tools and equipment:		
Field	32	35
Using personnel	21	32
Tables:		
Assembly of borescopes (IV)		22
Bore magnification (V)		25
Pullover gage stops for artillery weapon inspection (III)		18
Pullover gages for artillery weapon inspection (I)		17
Rod assemblies for artillery weapon inspection (II)		18
Special tools and equipment (VI)		32
Test and adjustment. (*See under specific item.*)		
Tools and equipment:		
Field:		
General	30	35
Maintenance parts	31	35
Special	32	35
Using personnel:		
Common	20	32
General	18	32
Spare parts	19	32
Special	Table VI	32
Transformer lighting. (*See* Lighting transformer.)		
Troubleshooting:		
Damaged lenses	27	34
Failure of head lamp to light	26	34
General	25	34
Unsatisfactory equipment	2*e*	2
Weapon Record Book	2*c*	2

[AG 413.8 (18 Jul 58)]

By Order of *Wilber M. Brucker*, Secretary of the Army:

MAXWELL D. TAYLOR,
General, United States Army,
Chief of Staff.

Official:

HERBERT M. JONES,
Major General, United States Army,
The Adjutant General.

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Ord Bn (2) except TOE 9-45, (None)
Ord Co (2) except TOE 9-12, 9-17, 9-46, 9-47, 9-57, 9-229, 9-347, 9-367, 9-387 (None)
Ft & Camps (2) except Ft Hood (7), Ft Sill (7), Ft Bliss (7), Ft Sam Houston (7)
Svc Colleges (2)
Br Svc Sch (2) except USA Ord Sch (50)
PMST Sr Div Ord Units (1)
Ord Ammo Comd (1)
Gen Depots (2)
Ord Sec, Gen Depots (5)
Ord Depots (10) except Rossford Ord Depot (11), Anniston Ord Depot (11)
Ports of Emb (OS) (2)
Trans Terminal Comd (2)
Army Terminals (2)
OS Sup Agcy (1)
Ord PG (10)
Ord Arsenals (5) except Raritan Arsenal (30), Frankford Arsenal (6), Benicia Arsenal (6)
Mil Dist (1)
US Army Corps (Res) (1)
Sectors, US Army Corps (Res) (1)
Ord Proc Dist (10)
MAAG (1)
Mil Mis (1)
JBUSMC (2)
JUSMAG (Greece) (2)

NG: State AG (6); units—same as Active Army except allowance is one copy to each unit.

USAR: None.

For explanation of abbreviations used, see AR 320-50.

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